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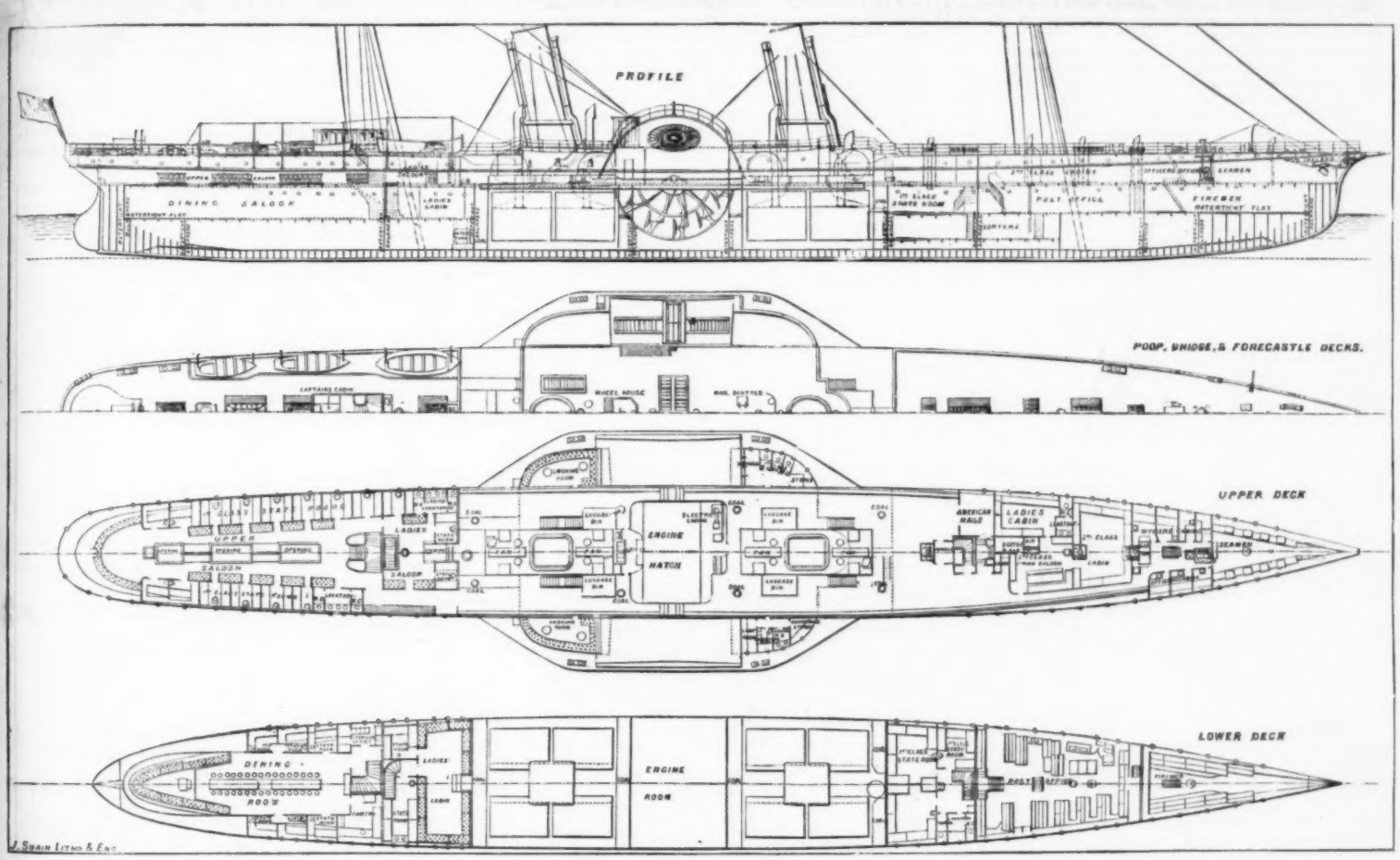
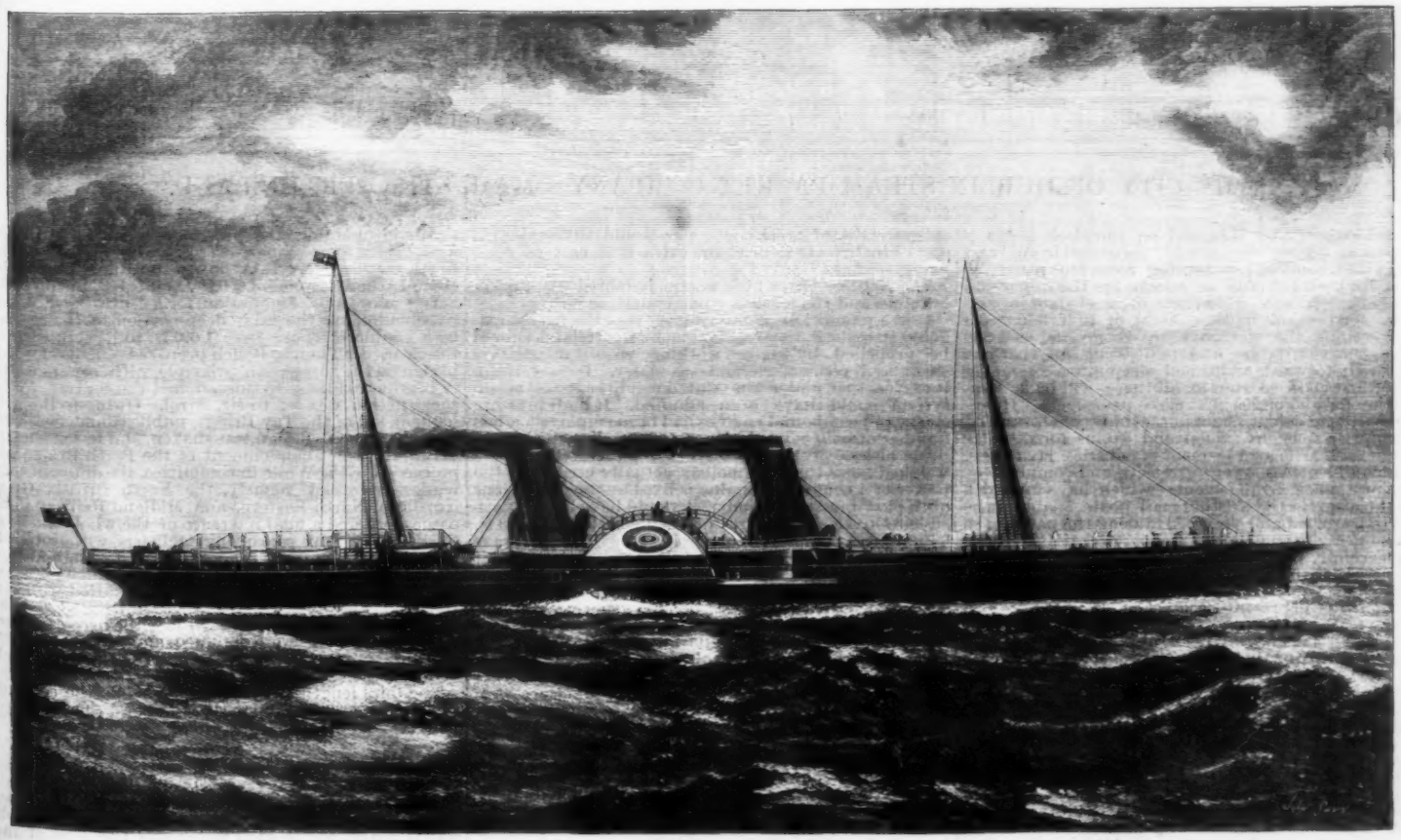
NEW MAIL STEAMER IRELAND.

WE illustrate the City of Dublin Steam Packet Company's new mail steamer, the Ireland, constructed by Messrs. Laird Brothers, of Birkenhead, to ply between Holyhead and Kingstown. Her trial trip lately took place, and was in every way satisfactory. She made the passage from Holyhead pier to Kingstown pier in two hours fifty-eight minutes, and on Aug. 27 ran from Kingstown to Holyhead against a strong head wind and tide in three hours seven minutes.

[We are not quite certain as to the exact distance,



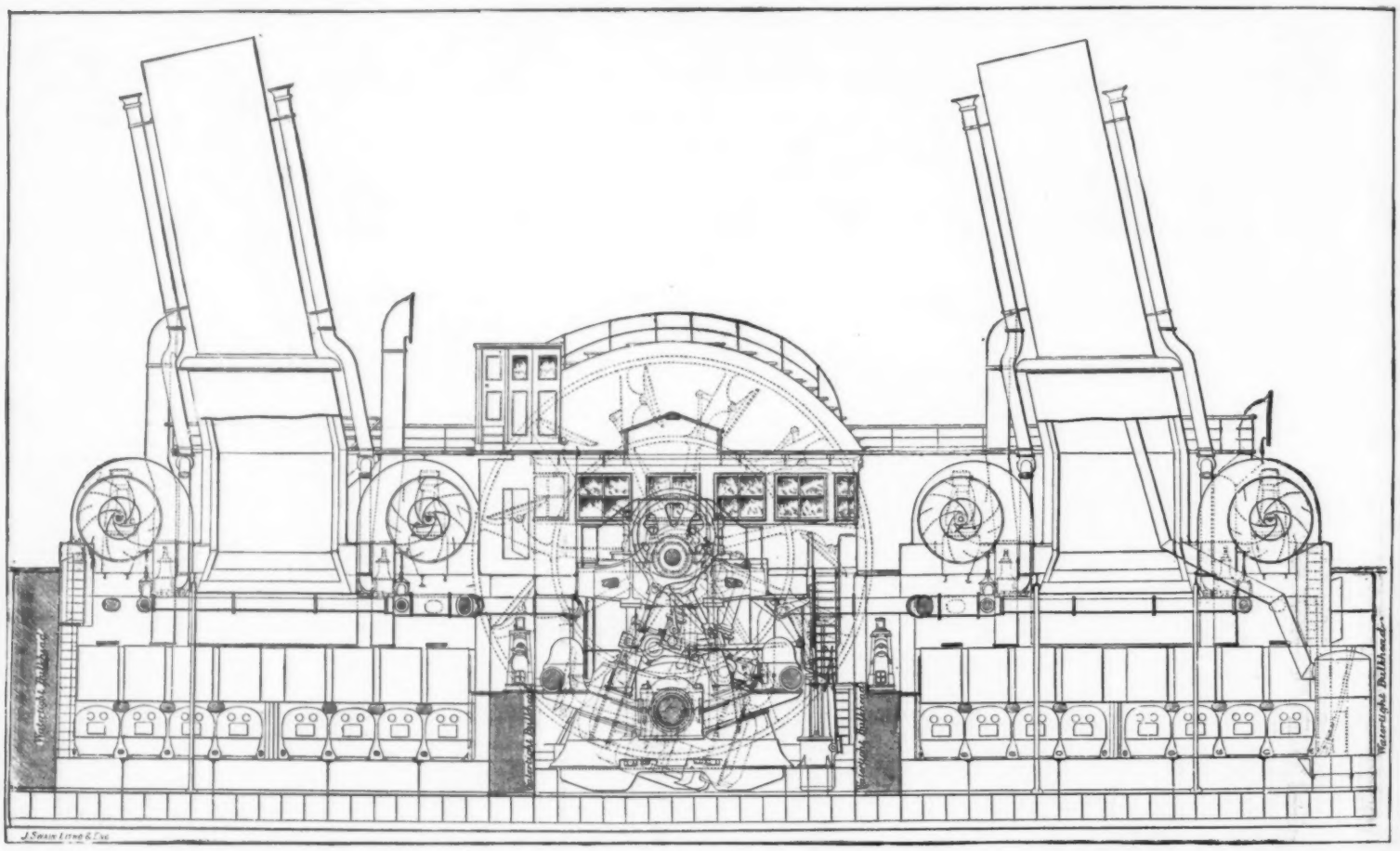


THE CITY OF DUBLIN STEAM PACKET COMPANY'S MAIL STEAMER, IRELAND.

but we think it is 65 miles from pier to pier, which would show a speed of close on to 23 miles an hour for the fastest run, probably the quickest ocean steaming ever made.—Ed. S. A.]

The Ireland is a magnificent specimen of naval architecture, graceful as a yacht, with finer lines than probably any sea-going steamer yet built, and of dimensions and power far surpassing any vessel ever turned out for similar service. She has a length over all of 380 ft., or between perpendiculars of 360 ft., with 38 ft. beam, and a depth in hold of 19 ft. 3 in., her tonnage being 3,590 tons O.M. She is built entirely of Siemens steel, in order that the greatest strength may be secured with the minimum of weight, so important for vessels designed for very high speeds, and is subdivided by steel water-tight bulkheads carried to the upper deck into eleven compartments, one of these bulkheads being between the engine-room and each boiler-room, so that the engines and each set of boilers are in separate compartments, and in the event of damage to any two compartments, the ship would still have sufficient buoyancy. In appearance she much resembles the present mail packets, having a clipper stem with shield head, and a short bowsprit, a light elliptic counter, two raking masts and two funnels, a spacious bridge deck amidships, a long poop aft, and hurricane deck forward.

The passenger accommodation is in arrangement the same as in the company's present steamers as now fitted, and on a scale such as could only be afforded in a vessel of these large dimensions, and is replete with every comfort and luxury which the most fastidious traveler can desire. In the poop is a large saloon about 80 ft. in length, paneled in polished hard wood, with



THE CITY OF DUBLIN STEAM PACKET COMPANY'S MAIL STEAMER, IRELAND.

state cabins on either side, and on the deck below is the spacious dining saloon, richly decorated in gold and color, with a commodious serving room and pantry at fore end. Forward of these saloons are the upper and lower ladies' saloons, which are most elegant apartments. The saloons have a height of 10 ft. 6 in. from deck to ceiling; the stairways are roomy and well arranged, the ventilation and light being all that can be desired; forward, additional sleeping accommodation for first-class, so that in all there will be accommodation for about 200 first-class passengers. Handsome and convenient smoking cabins are provided amidships; a spacious saloon and cabins forward for second-class. The arrangement of pantries, lavatories, and such like offices is very extensive and complete.

The post-office arrangements—which have formed a special feature in the existing mail boats, enabling the mails to be sorted and stamped during the passage, so as to be ready for immediate delivery on arrival—have been carefully provided for, spacious rooms having been fitted for the purpose, and a cabin set apart for the post-office officials in the same way that has already been done in the present packets.

The vessel throughout is illuminated by the electric light—the fittings having been supplied by Messrs. Edmundson & Co., of Dublin—with the exception of the post-office, which is lighted on Pintsch's patent oil gas system by the Pintsch's Patent Lighting Company.

The steering gear and anchor gear are worked by steam, and all the arrangements conducing to the safe conveyance of passengers are of the most modern and improved type.

The engines are oscillating, of the ordinary double piston-rod jet condensing type, having two diagonal air pumps worked by an eccentric on the intermediate shaft. The cylinders are 102 in. diameter and 102 in. stroke; the piston-rods are of steel, 10½ in. diameter. The entablatures are of cast iron and of box form, and are strongly supported by eight wrought iron columns, each 9¼ in. diameter. The shafts, cranks, and crank pins are of Whitworth's fluid compressed steel, the shafts being 24¼ in. diameter in the bearings and hollow throughout, the diameter of hole being equal to one-half the diameter of shaft. Each cylinder has two slide valves, worked by a link motion in the usual way; and a combined steam and hydraulic starting gear enables the engineer to handle these powerful engines with great rapidity.

The paddle-wheels are 33 ft. 4 in. in diameter over the floats, eleven floats to each wheel, 13 ft. wide, and 5 ft. 9 in. deep.

Steam is supplied by eight rectangular boilers made of steel, four placed before and four abaft the engines, working at a pressure of 30 lb. per square inch. The boilers contain in all thirty-two furnaces, 3,168 tubes, and have a total heating surface of 22,750 square feet, and a grate surface of 807 square feet. The boilers may be worked under natural draught or under air pressure, sufficient ventilation being provided for the former, while the stokeholes can be readily put under air pressure by closing the ventilators and working double fans placed on deck. These double fans are four in number, 8½ ft. diameter, each driven by two separate engines, and capable of maintaining an air pressure equal to 2½ in. of water in the stokeholes.

Jet condensing engines have been adopted on the score of lightness, in order to get the requisite power on small displacement; and indeed for this service, where the run from port to port is very short and good coal got at a low price, compound engines do not offer any advantage, seeing that the reduced weight of coal to be carried would not go far to compensate for the extra weight of machinery, nor would the saving in cost of fuel go far to meet the extra first cost of compound engines.

The Engineer, to which we are indebted for our engravings and the foregoing particulars, says:

It is a remarkable circumstance that the fastest sea-going steamer in the world, namely, the Ireland, should be propelled by engines working with low pressure steam, jet condensers, and sea water. It is certain, however, that under the stated conditions no better system could have been adopted. If high pressure steam and compound engines had been employed, a less number of boilers would have sufficed, but the boilers being necessarily of much thicker plates would have weighed more than the boilers actually used. As the power of a compound engine is fixed by the dimensions of the low-pressure cylinder, it would have been impossible to make the low-pressure cylinder less than 8 ft. 6 in. diameter by 8 ft. 6 in. stroke, even if the average pressure had been so great as it is now. In practice it would have to be less, in order that much economy might be realized; and it is probable that as the stroke actually used is the greatest possible, the low pressure cylinder must have been 120 in. in diameter—a very objectionable size for an oscillating engine. The weight of the surface condenser would have been enormously greater than that of the jet condenser, and the space occupied would also have been larger, while the cost of the engines and boilers would be augmented in proportion. The saving effected in the cost of fuel would not have compensated for all this. Assuming that the ship requires 4 lb. per horse power per hour, we have for 6,000 horse power a little over 10 tons per hour, or, say, 30 tons for the trip, representing about £15; or, allowing 10 tons for raising steam, we have, say, £20 per voyage—a comparatively insignificant amount. Space is easily found for all the coal it is necessary to carry. The loss by blowing off is reduced to a minimum. In the case of vessels making long voyages, about one-fourth of all the water pumped in has to be blown overboard at boiling heat, in order to keep the boilers from being salted; but the Holyhead and Kingstown mail boats are as a rule not blown off at all while at sea. They are blown down at the end of each trip, and filled up again, and thus the heat of the boilers, which would be otherwise wasted, is utilized. The superintendent of the company's ships has long used a boiler fluid which works remarkably well with sea water, bringing down the lime and magnesia salts, not as a hard scale, but in the form of mud, which is easily washed out. The facts in this case are very instructive, for they teach in forcible language the truth that circumstances alter cases, and that the machinery which is best for a long voyage steamer is not necessarily that best adapted for such a service as that which the City of Dublin Steam Packet Company so ably carries on.

THE FORTH BRIDGE.*

By Mr. B. Baker, M.I.C.E., London.

The North British Railway Company for many years have driven hard to obtain a physical connection of their lines north and south of the Forth by means of a bridge. Twenty years ago they were authorized by Act of Parliament to build a bridge across the Forth at a point five miles above the site of that now under construction, but borings 120 ft. in depth showed nothing but soft silt and mud, and the bridge, which was to have been two miles in length, inclusive of four spans of 500 ft. each, was luckily abandoned, as the difficulties with the foundations would have proved practically insuperable. In 1873 another Act was passed for a bridge across a narrower and deeper part of the Forth at Queensferry. At low water the width of the channel there is about 4,000 ft., and the island of Inchgarvie affording a foundation for a central pier, it was possible to cross the 200 ft. deep portion of the seaway by a couple of spans from 1,600 ft. to 1,700 ft. each in the clear. Sir Thomas Bouch prepared a design for this bridge on the suspension principle, with towers 665 ft. in height from base to summit, and the contract for its construction was let to Mr. Arrol. Owing to the subsequent fall of the Tay Bridge, public confidence in Sir Thomas Bouch's design was shaken, and in session 1881 a Bill for the abandonment of the Forth Bridge was proceeded with. While in committee, the different companies interested, namely, the North British, Great Northern, North Eastern, and Midland Railway Companies, ordered a final reference of the whole question to their respective consulting engineers, with the result that the abandonment Bill was dropped, and the design for the cantilever or continuous girder bridge prepared by Mr. Fowler and myself, in consultation with Mr. Harrison and Mr. Barlow, was substituted for the original suspension bridge. In 1882 the necessary Parliamentary powers were obtained, and in January, 1883, the works were commenced by Messrs. Tancred, Arrol, and Co., the contractors.

The total length of viaduct included in the contract sum of 1,600,000 *l.* is about 1½ miles, and there are

2 spans of	1,710 ft.	each
2 "	675 "	
15 "	168 "	
5 "	25 "	

Including piers, there is thus one mile of main spans, and half a mile of viaduct approach. The clear headway is 150 ft. above high water, and the tops of the

* Paper read before the Iron and Steel Institute at Glasgow.

great cantilevers are more than 200 ft. higher still. There will be about 45,000 tons of steel in the superstructure of the bridge, and 140,000 cubic yards of masonry in the piers.

Piers.—The South Queensferry main pier consists of a group of four cylindrical piers of masonry and concrete, founded by means of pneumatic caissons on the strong bowlder clay constituting the bed of the Forth at this point. Owing to the slope of the clay, the caissons required to be sunk to depths varying from about 70 ft. to 90 ft. below high water. The diameter ranges from 70 ft. at the base to 60 ft. at low water level, above which the iron skin of the caisson is replaced by a facing of Aberdeen granite. At the base of the caissons is a working chamber 7 ft. in height, supplied with compressed air, and electrically lighted, for the men excavating the material. This chamber was kept clear of water by a pressure of air considerably less, as a rule, than that due to the head of water outside. For example, at 90 ft. below high water, when the northeast caisson had been sunk through a considerable thickness of silt, the air pressure required to be maintained at 18 lb. per square inch only, although at the reduced depth of 57 ft. it was found convenient to work at 30 lb. air pressure. Three shafts and air locks were provided for each caisson, two for the excavated material, and one for the men. The former had two horizontal sliding doors actuated by small hydraulic rams, and the skip containing the clay and bowlders was hoisted up the 90 ft. shaft by a steam engine mounted on the side of the air lock. As a rule, from 200 to 300 skips of excavated material were raised per day of 24 hours by a force of from 20 to 30 men. The maximum number of skip loads was 363, and of men 33. The size of the skips was 3 ft. in diameter by 4 ft. 3 in. high. Owing to the extreme hardness of the clay it was necessary to provide a certain number of spades having hydraulic rams in the handles, which abutting against the roof of the working chamber, sliced the clay readily.

At the present time three of the South Queensferry caissons have been sunk successfully to the full depth, and the fourth and last would also have been completed but for an unfortunate accident which happened to it at the beginning of the year. By some means the caisson, which had been floated into position for some weeks, accidentally filled with water, and sank and slid forward on the mud. It is now being carefully cased in timber to admit of the water being pumped out and the caisson floated again into position.

At Inchgarvie similar pneumatic caissons are used for two out of the four cylindrical piers, and the work on both is in full progress. Owing to the slope of the bock bottom, is is necessary to cut away as much as 18 ft. in thickness of whinstone rock to form a level bench for the pier at 70 ft. below high water, and the most convenient way of doing this was to convert the base of the pier practically into a great diving bell 70 ft. in diameter. In this case, there being no silt over the rock, the pressure of air necessarily is that due to the depth of water outside, and somewhat sensational "blows" occur with a falling tide. Rock drills are provided, and blasting goes on in the compressed air chamber without necessitating the withdrawal of the men.

At North Queensferry, the four main piers were built either on dry land or within timber and clay cofferdams. Above low water the whole of the main piers are built of Arbroath masonry in cement, faced with Aberdeen granite, and hooped occasionally with 18 in. wrought iron bands. The cantilever end piers, and the viaduct piers, are built of rubble, concrete, and granite in cement.

Superstructure.—Although the piers of the Forth Bridge present many points of interest, it is the enormous span and novel design of the superstructure that has attracted the attention of the engineers of the world to the work now in progress at Queensferry. The chief desiderata in the biggest railway bridge ever proposed to be constructed are durability, strength, and rigidity under express trains and hurricane pressure; facility and security of erection, high quality of material and workmanship, and economy in first cost and maintenance. These, we considered, would be best met by a steel "cantilever" or "continuous girder" bridge. Since the commencement of the Forth Bridge, American engineers, ever bold and ready, have built three cantilever bridges of considerable spans, and practical experience has confirmed our anticipations as to the advantages of the system; the Niagara Bridge, over 900 ft. in length, which was manufactured and erected across the rapids in the short time of ten months, having stood all the tests of actual working in the most satisfactory manner.

In the Forth Bridge, each span of 1,710 ft. is made up of two cantilevers, projecting 680 ft., and a central girder connecting the same 350 ft. in length. The cantilevers are 343 ft. deep over the piers, and 40 ft. at the ends. The bottom members consist of a pair of tubes tapering in diameter from 12 ft. to 5 ft., and spaced 120 ft. apart, center to center, at the piers, and 31 ft. 6 in. apart at the ends.

The top members consist of a pair of box lattice girders, tapering in depth from 12 ft. to 5 ft. and spaced 33 ft. apart at the piers, and 22 ft. 3 in. at the ends. Each tube has a maximum gross sectional area of 830 square inches, and each girder a maximum net sectional area of 506 square inches. Upon each cylindrical masonry pier is bolted a bedplate carrying a "skewback," from which spring vertical and diagonal columns and struts. The former are 12 feet in diameter, and from 368 to 468 square inches sectional area; the latter are flattened tubes. Horizontal wind bracing of lattice girders connect the tubes forming the bottom member of the cantilevers, and similar vertical windbracing connects the vertical and diagonal tubes, so that the whole structure is a network of bracing capable of resisting stresses in any direction and of any attainable severity.

The rolling load provided for is (1) trains of unlimited length on each line of rails weighing one ton per foot run; (2) trains on each line made up of two engines and tenders, weighing in all 142 tons, at the head of a train of sixty short coal trucks at 15 tons each. The wind provided for is a pressure of 56 lb. per square foot striking the whole, or any part of the bridge, at any angle with the horizon, the total amount on the main spans being estimated at no less than 7,900 tons. In practice only two trains, weighing 800 tons in all, would be on this length of bridge at the same time, so the wind pressure (if such a hurricane is 56 lb. per square foot could ever occur) would be ten times as great as the train load. Under the combined stresses resulting from the test load in the worst position, and the heaviest hurricane, the maximum stress on the steel will not exceed 7½ tons per square inch on any portion of the structure, and on members subject to great variation in the intensity and character of stress, the maximum will not exceed 4 tons per squere inch. For tubular columns and struts 34 to 37 ton steel, with an elongation of 17 per cent. in 8 in., is specified, and for tension members 30 to 33 ton steel, with 20 per cent. of elongation. We have now about 15,000 tons of steel delivered and worked up, and are satisfied that the quality as supplied to us by the Steel Company of Scotland and the Landore Company is admirably adapted for bridge construction. In making the tubes, the plates are heated in a gas furnace, and bent hot between dies, in a powerful hydraulic press. A slight distortion takes place in cooling, which is corrected by pressing the plates again when cold. After bending, all four edges are planed, and the plates built up into a tube. Traveling annular drill frames surrounding the tube, fitted each with ten traversing drills, bore the holes at once through plates, covers, and stiffeners, so that when again fitted in place for erection, every piece comes into exact juxtaposition. Similar traveling drill frames deal with the lattice box girders, every hole being drilled as the machine advances. Generally the plant designed by Mr. Arrol for drilling the innumerable holes in the 42,000 tons of steelwork for the main spans is of signal merit and efficiency, and well worthy the attention of practical engineers.

At the present time, although, as already stated, about 15,000 tons of steelwork is on the ground, only the approach viaduct girders and some of the bed plates of the main spans are erected and riveted up. In a few weeks, however, the erection of the portion of the main spans over the North Queensferry piers will be proceeded with. The "skewbacks" and the connecting tube will first be riveted up, and then a platform of temporary girders and planking will be constructed, and raised gradually by hydraulic rams in the four vertical 12 ft. diameter columns as the work of erection and riveting up progresses. This platform will carry cranes and other appliances, and the men will be thoroughly protected, so that work may be carried on with as much confidence at a height of 350 ft. as at a sea level. When the portion of steelwork over the piers is erected, the first bay of cantilever on each side of the same will be added, the work forming its own staging. This will be followed by succeeding bays until the cantilevers are complete, and the central girders will be erected, probably on the same plan.

It will be observed that for certain parts of the Forth Bridge we use steel of a higher tensile strength than is at present considered admissible either for ships or boilers. This has not been done without full and mature consideration of the whole question. Our experiments showed that steel having a tensile strength of from 34 to 37 tons per square inch offered a decided advantage over very mild steel, when compressive stresses and the flexure of long columns were concerned. Indeed, an inferior quality of steel, such as would be used for rails, will stand compression far better than the best boiler steel or Lowmoor iron. Thus, I found a column 20 diameters in length of common Bessemer steel carry 27 tons per square inch, where one of mild boiler steel has stood but 17 tons. It would be inexpedient, however, to use inferior steel even for the compressive members of a bridge, and therefore a high quality and high tensile resistance were indicated. Although this steel takes a temper and becomes brittle if cooled in certain ways, it will stand the ordinary Admiralty temper tests, bending to a radius of double the thickness, after being made red-hot and cooled in the usual way. In a boiler the steel plates are subject to great changes of temperature and consequent stresses from expansion and contraction. In a ship almost every plate in the hull is subject to alternate tensile and compressive stresses when among waves; and further, a vessel is liable to severe alternating stresses and shocks on taking ground, dry docking, and under other circumstances. In the compression members of the Forth Bridge, the steel is subject only to a steady pressure of varying intensity, and a quality of steel was adopted which combined perfect facility in working with a high resistance to compression. Although an increased tensile strength is accompanied by a decidedly increased resistance to flexure in columns and struts, the latter is not proportional to the former. If the thing were practicable, what I should choose as the material for the compression members of a bridge would be 34 to 37 ton steel, which had been previously squeezed endwise in the direction of the stress to a pressure of about 45 tons per square inch—the steel plates being held in suitable frames to prevent distortion.

My experiments have proved that 37 ton steel so treated will carry as a column as much load as 70 ton steel in the state in which it leaves the rolls, that is to say, not previously pressed endwise. It would be a matter of much practical moment to ascertain if some convenient treatment could be devised which would endow steel with this greatly increased power of resistance to compression without injuring its resistance to tension, or its ductility, which remained unaffected by previous compression in my experiments. At least one-half of the 42,000 tons of steel in the Forth Bridge is in compression, and the same proportion holds good in most bridges, so the importance of gaining an increased resistance of 60 per cent. without any sacrifice in the facility of working, and safety belonging to a highly ductile material, can hardly be exaggerated.

Our experience has led us to the conclusion that sheared edges are a more fruitful source of fracture than partial tempering, or other contingencies. All of our bent plates are made red-hot, and the effect of the shearing is thus eliminated even before planing. Those plates which are not heated have the edges carefully planed so as to leave no trace of the shearing, and we find that whether we are dealing with 30 ton or 37 ton steel, the plates so treated stand all the desired tests. Experiments which I have made, and am still making, on the resisting power of different classes of iron and steel to repeated bendings, such as the shaft of a marine engine undergoes if the bearings get out of line, indicate that the superiority of low tension steel is considerably greater than the increased ductility would indicate.

In conclusion, I may state that the approximate value of the plant now at the Forth Bridge is 250,000*l.*, and of the work executed 600,000*l.*

THE PHOTOSCOPE.

THE disks designed to protect railway stations are at present located at some distance from the point to be covered, sometimes as far off as 1,800 yards; so, in order to avoid the necessity of continually running backward and forward in order to maneuver them, they are actuated by means of a galvanized iron wire running over pulleys. This wire is acted upon by means of a lever located at the station, and provided with a counterpoise. When the traction upon the wire ceases, a counter-lever located beneath the disk effaces the signal.

When, as is frequently the case, certain obstacles prevent the disk being seen by the man who maneuvers it, it is none the less necessary that this person shall be able to control its position. To this end, it is put in communication with a small electric bell that is placed along side of the signalman. This bell rings when the disk is in its position to show danger, and all the time

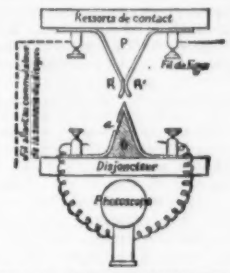


FIG. 1.—DISCONNECTOR.

that it remains so, and stops, when the disk shows that the track is clear, through the play of a commutator placed upon the disk's axis. In this way the station can effect its maneuvers in all security, since it suffices to hear the ringing of the bell in order to know that the station is covered by its advanced signals. But at night such security may prove deceptive. In fact, the lantern of the disk may become extinguished by wind or some other cause. In this case, if the station turns its disk to a position to show danger ahead, the bell rings, and it might be thought that all was right. In reality, however, such would not be the case. Should a train come along at this juncture, its enginemen, not observing the red light, would pass by the disk and continue to advance, on the principle that the absence of a signal indicates a clear track. It may be easily seen what disastrous consequences might accompany the accidental extinction of a disk lantern. The researches that have been made with the object in view of allowing it to be seen whether or not the lantern is lighted have led to the use of the *photoscope*, an apparatus which is now applied upon the line from Paris to Lyons and the Mediterranean to all the disks that are invisible at the stations whence they are maneuvered. The photoscope consists of the following parts: (1) of a piece of wood, P, provided with springs, RR', and fixed at the top of the disk; (2) of a disconnector, D, fixed to the lantern and surmounted by a wedge whose metal-covered sides, interrupted at *a*, separate the springs, RR', when the lantern is in place at the top of the disk, and oblige the current to traverse the photoscope (Fig. 1); and (3) of the photoscope properly so called, which is formed of a spiral, S, composed of two juxtaposed metals of unequal expansion (copper and steel), and which is placed horizontally, above the flame, in the lantern chimney (Fig. 2).

The unequal expansion of the two metals causes the spiral to open, and the free extremity, *a*, of the latter pushes the spring, *r*, and causes it to bear against the contact, *c*. As this spring and contact communicate respectively with one of the surfaces of the wedge, the circuit is closed at this point and the current can pass. If the lamp chances to get extinguished, the spiral of the photoscope cools and consequently contracts. The spring, *r*, being left to itself, resumes its normal position, the circuit is interrupted, and the current can no longer pass. Thus, when the lantern is placed at the

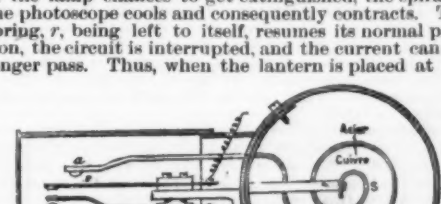


FIG. 2.—PHOTOSCOPE.

top of the pole, and the lamp is lighted, it is necessary that the following conditions be fulfilled in order that the bell shall ring: first, that the disk be set to signal danger, and second, that the lamp be lighted. Consequently, if at night the bell is ringing when the disk lever is down, it may be certain that the disk is properly set and that its light is all right. If, on the contrary, the bell is not ringing, it must be concluded either that the disk has not operated well or that the light is out. In such a case a man must be at once dispatched to the disk, either to relight the lamp or to set the signal by hand. A special arrangement of the chain permits of the lantern being kept 8 inches beneath its night position during the day. Under such circumstances, the bell operates exactly as if the disk were not provided with a photoscope, since otherwise things would be in the same state as if the light were out.

In order to have the photoscope operate regularly, certain precautions are indispensable. Thus, the metallic spiral must be examined from time to time and freed from the lamp-black that accumulates upon it,

and that might, by dropping, put out the lamp. On another hand, it is necessary that the current of hot air that rises through the chimney shall act with sufficient intensity, and that its action shall likewise extend over the entire surface of the spiral. In order to obtain such a result, the flame must be strong, the wick be not carbonized, and the chimney be vertical, so that its axis shall pass through the center of the spiral. Finally, the lamp cleaners must trim the wick well, regulate the flame properly, and put the chimney on with care, and, in raising the lantern, avoid all shocks that might get the chimney out of a vertical position.—*La Nature.*

THE BESSBROOK AND NEWRY ELECTRICAL TRAMWAY.

This tramway has been at last completed. On September 10th it was examined officially by Major-General Hutchinson and Major Armstrong, R.E., on behalf of the Board of Trade, and it has passed without any alteration being required. The Bessbrook Spinning Company, owning very extensive mills and granite quarries at Bessbrook, has hitherto been obliged to cart all coals, goods, and stores from the wharves and railway stations, at Newry, a distance of three miles. This traffic, including that incident to the village of Bessbrook, amounts to about 28,000 tons annually, and much inconvenience has been felt from having no better method of conveying it than ordinary carts. The directors of the company have for some time had in contemplation the establishment of a tramway between Newry and Bessbrook, but the great obstacle to the carrying out of this has been the difficulty which would be encountered at both ends by the transshipment of the goods being necessary, as there were difficulties in carrying the tramway at the one end to the railway stations, and at the other to the various departments of the mills. These difficulties have now been entirely overcome by a modification of the usual wagon. The wagons are constructed with wheels having no flanges, and of sufficient width of tire, 2½ in., to allow them to run upon the ordinary roads of the country. The front part of the wagon is carried on a bogie, which can either be pinned so as to make a fixed wheel base, or can be allowed freedom of movement as in an ordinary road vehicle. To the fore bogie horse shafts can be attached for use on the roads. The wagons will carry a maximum load of two tons each, which, except upon very steep gradients, an ordinary horse can draw on the country roads. On the outside of the ordinary tramway rails, second rails have been laid of a lighter section, to which the ordinary rails act as a guard. The flangeless wheels run upon these outside rails, and their motion is restricted by the inside rails. This ingenious plan was suggested by Mr. Henry Barcroft, director of the Bessbrook Spinning Company. The only motive power employed is electricity, and this is generated entirely by water power, so that steam plays no part whatever in connection with this line. The whole of the electrical details and all matters connected with the electrical equipment have been designed and carried out by Dr. Edward Hopkinson, of Manchester, who also, under the direction of the late Sir W. Siemens, carried out the electrical portion of the work in connection with the Portrush and Giant's Causeway Tramway. The present line, however, shows advances in almost every point upon the Portrush Tramway. Though only three miles long as compared with five miles at Portrush, the loads to be carried are far in excess of those at Portrush. In the latter place the passenger traffic only is provided for electrically, and that only partially, but here both goods and passengers are carried by the same means.

The maximum gross load is 26 tons, consisting of a train of six wagons, which carry about two tons each, and the electrical locomotive, weighing eight tons, which also forms the passenger carriage, and is capable of accommodating thirty four passengers. This load can be brought up inclines averaging 1 in 85, at a speed of seven miles an hour, and up the stiffest incline of 1 in 50 at a speed of six miles an hour. The train can be started at any point on the line, even on the stiffest incline, with perfect ease. This is much in excess of the work done at Portrush, and much greater than has been accomplished on any of the German or American electrical railways.

The water power for the working of the line is situated about two-thirds of the distance from Newry, at Millvale, where there is a considerable fall. A turbine capable of developing up to 65 horse power has been erected by Messrs. MacAdam Brothers, of Belfast, and two generating dynamos, each capable of working the full load, constructed by Messrs. Mather and Platt, of Manchester. They are of the well-known Edison-Hopkinson type.

The current from the generating dynamos is conveyed to a convenient switch board, and thence to the conductor, which consists of an inverted steel channel carried on insulators, and fixed midway between the ordinary tramway rail. From the conductor the current is taken to the motors on the car. These have been constructed by Messrs. Mather and Platt, and are of the same type as the generators. They have been specially designed by Dr. Edward Hopkinson for the work which they have to do, and are capable of developing up to 25 indicated horse power. The car is geared so as to be able to run at a maximum speed of fifteen miles per hour, and this speed is easily attained on the level and up the whole line, when the car only is run without the train of trucks. The two cars which constitute the passenger department of the rolling stock, and which are both fully equipped electrically, have been built by the Ashbury Carriage Company of Manchester.

The driver stands in front on a platform, and has complete control. The cars are carried on bogies at both ends, and, though 35 ft. long over all, they readily pass round the terminal curves at either end of the line, the radius of which is only 55 ft. This arrangement enables the car to always run in the same direction, so that there is no need to reverse it, which can, however, be easily done. About the middle of the line, at Millvale, there is a country road which the tramway crosses at an angle, so as to make a level crossing of over 50 yards in length. The conductor could not be carried here in the same way as over the rest of the line for fear of injury to passing horses, but the difficulty has been got over in a most ingenious manner. Instead of being carried at the level of the rails, the conductor is supported overhead, and consists of two copper wires carried at a height of about 15 ft., which will allow of any loaded carts passing freely underneath. The car passes under the supports of these wires, and a collector fixed on its top catches the wires and slightly lifts them, making a good contact. The current is thus never broken, and the wires can hang quite freely without any special form of collector being necessary beyond an iron bar across the top of the car. This plan has been patented by Dr. John Hopkinson. The permanent way has been constructed under the direction of Mr. J. L. D. Meares, C.E., of Newry, assisted by Mr. F. S. Thomas, C.E., and is of substantial construction throughout.—*The Engineer.*

SOME NEW MIRROR GALVANOMETERS.

Messrs. Hartmann & Braun, of Backenheim, have just constructed a galvanometer which is a combination of the reflecting and needle apparatus. Fig. 1 gives a perspective view of it. A small Siemens magnet is suspended in the interior of a copper cylinder in such a way that its movements are nearly periodical. The magnet carries a brass rod to which is fixed the mirror whose window is shown at M. Above this window there is a sort of circular box with a glass cover that contains a graduated limb, as well as a very fine aluminum index, attached to the magnet support. The suspension wire is in the interior of the brass tube seen above the glass disk. The apparatus is provided with two bobbins, B and B', one of which, B, is stationary, while the other is movable along a system of slides that likewise conducts the current.

The extremities of the bobbin wire are fixed to the terminals, *a*, *b*, *c*, *d*, so that the following combinations can be made: (1) bobbin A alone; (2) bobbin B alone; (3) bobbins B and B' in series; and (4) bobbins B and B' in derived circuit. The bobbin B' can be held stationary by two screws, V and V'.

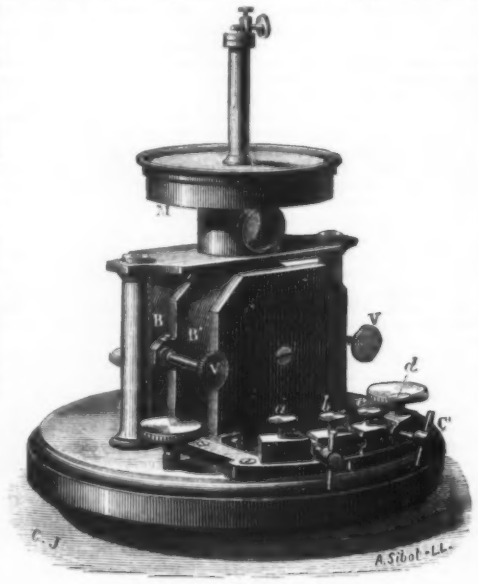


Fig. 1.

The same house is constructing another galvanometer, which is shown in Fig. 2. If, as well known, we place a soft iron magnet in a magnetic field so that the axis of the ring be at right angles with the lines of force, the ring will allow but very few lines of force to pass into its interior, while the larger portion of such lines will be deflected, and will remain in the mass of the ring.

Fig. 2.

The diagram (Fig. 3) shows the distortion that the magnetic field is submitted to under such circumstances. It will here be seen that the intensity of the magnetic field in the interior of the ring is exceedingly feeble in proportion to what it is outside of it. It is this property of soft iron rings that has served as a starting point to Messrs. Hartmann & Braun in the construction of their galvanometer. Fig. 2 shows the details of its construction well enough. A Siemens magnet, D, is suspended by a cocoon fiber in the ordinary way. Above D may be seen the mirror window, as well as the lantern thereof, suspended by two vertical pillars. Along these latter slide two collars connected with a soft iron ring. By moving this latter, it is possible to modify the magnetic field in which the magnet is situated, and give the apparatus more or less sensitiveness.

Fig. 3.

The deadener is of copper, and consists of two cylindrical rods. The apparatus consists of two bobbins, which may be grouped in different ways, and which are movable along a rack fixed to the tube, T. With these mirror galvanometers Mr. Hartmann employs graduated telescopes of ingenious construction. These are mounted upon a tripod provided with leveling screws. A small rack and pinion permits of varying the height of the apparatus. The telescope is moved around the horizontal and vertical axes by means of the screws, V and *s*. The apparatus is focused approximately by maneuver-

Fig. 4

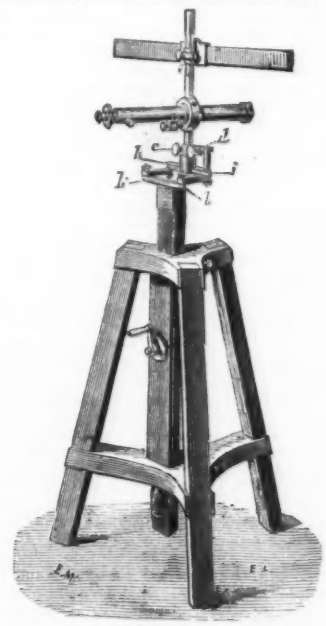


Fig. 5.

ing the telescope, after unscrewing B and *v*. The scale, E, is fixed to a support, and its weight is balanced by a counterpoise, P.

The apparatus is very light and convenient. The use of it is not limited to the angular motions of a mirror around a vertical axis. In order to adapt it for observations of angular motions around a horizontal axis, it suffices to remove the scale and its support, and to fix the latter upon the horizontal cylinder situated a little above the bearings of the telescope.

Fig. 5 represents a telescope constructed by Dr. Edelmann, of Munich, and designed for use in laboratories of physics. The apparatus is mounted upon a large wooden tripod, thus giving it great mobility

A parallelogram, *h*, *i*, *k*, *l*, serves for slight lateral movements, the screw, *d*, for slight angular ones in a horizontal plane, and the screw, *e*, for angular motions in a vertical plane.—*La Lumiere Electrique.*

[ELECTRICAL REVIEW.]

REIS' TELEPHONES.

IN your issue of to-day you reproduce an extremely interesting article from the SCIENTIFIC AMERICAN, in which the following passage occurs respecting the early instruments described in 1861 by Reis, and in 1876 by Bell:

"In both instruments is latent the capacity for transmitting speech, but by neither Bell nor Reis was this power distinctly claimed. . . . Both inventors appear on the field with devices adapted for the same end, but neither with perfect distinctness claims this function as a part of the invention."

Permit me to point out that these assertions are not justified, so far as Reis is concerned, by the facts. He most unmistakably stated that his instrument was *intended to transmit speech*. The transmission of music by it was merely an after-thought.

The very first sentence of the very first paper written by Reis on the telephone, in 1861, is as follows:

"The surprising results in the domain of telegraphy have often already suggested the question whether it may not also be possible to communicate the very tones *of speech* [die Tonsprache selbst] to a distance." There is no ambiguity here as to the intention. Then he states his first prime difficulty. "How could a single instrument reproduce at once the total actions of all the organs operated *in human speech?*" His solution of that cardinal problem was the construction of his first transmitter in the form of a model of the human ear, having at the back of the tympanum a metal microphone with spring contacts to imitate the human ear-bones. He then said, after describing the apparatus, "I give to my instrument the name '*Telephon*.' . . . Until now it has not been possible to reproduce *the tones of human speech* with a distinctness to satisfy everybody. *The consonants* are for the most part tolerably distinctly reproduced, but *the vowels* not yet in an equal degree." These sentences are quoted from the paper contributed by Reis in December, 1861, to the annual report (Jahresbericht) of the Physical Society of Frankfort-on-the-Main, of which Reis, Faraday, Brewster, and Wheatstone were members. They establish beyond all cavil the following points:

1. Reis intended to transmit "the very tones of human speech."

2. The "tones of human speech" included "consonants" and "vowels," in other words, what some people prefer to call articulate speech as distinguished from mere musical sounds.

3. The apparatus was more successful with consonants than with vowels, and though its articulation did not satisfy *everybody*, it is clear that it satisfied some. (This is not surprising, since the vowels are the least important part of speech, and may be altered without affecting intelligibility, as is the case in the differences between different dialects.)

All this was in 1861. In 1863 Reis published printed directions for using the improved instruments, and in these directions told the person listening to the receiver how to signal instructions to the speaker at the transmitting end: "One beat = sing; two beats = speak." These instructions were circulated in Germany, France, and England from 1863 to 1867.

I cannot understand how, in the face of these things, it is that even those who are desirous of giving Reis his just due so often fail in their endeavor. Nothing could be more appreciative, more fair, than the intentions of the writer of the article in the SCIENTIFIC AMERICAN. Yet he says Reis never claimed "this function [*i. e.*, transmitting speech] as a part of his invention." *Never claimed this function!* Why, that was the starting point of the invention, its pith, its marrow. That was the dream which for nine years had wrought in his brain before he had made a single experiment. That was the essence of the invention which he brought to the birth, and gave freely and without reservation to the scientific and commercial world, the invention which he lived for, and wrapped himself up in, until his all too early death. I say nothing here of the abundant evidence of contemporary documents and contemporary witnesses. I leave Reis' own written and published words to speak for themselves. *Litera scripta manet.* Not even the ability of the smartest Yankee lawyer can destroy the evidence to be found on the shelves of every great European library. Mr. Dickerson will find that out some day, perhaps when all the world (except himself) has ceased to ignore the very stubborn fact that Philipp Reis did actually write these unmistakable sentences in 1861, about his invention for transmitting speech.

I have spoken of Reis and what he described as his invention in 1861 and 1863. Let me extract from Bell's specification (U. S.) of 1876 the passages which relate—as we are now told—to the transmission of speech:

"There are many other uses to which these instruments may be put, such as . . . the telegraphic transmission of noises or sounds of any kind."

"One of the ways in which the armature may be set in vibration has been stated to be by wind. Another mode is . . . by the human voice or by means of a musical instrument."

"I claim" . . . "The method of and apparatus for transmitting vocal or other sounds telegraphically."

The language of Bell's specification is more general than that of Reis, but it is at the same time far less significant or descriptive. Plenty of matter about "musical notes," and "dot and dash," and "signals" of Morse code, and "pitch," and "amplitude," and "multiple telegraphy," but never a word about "speech," or "consonants," or "vowels," no instructions how to signal to your friend when to "speak." No; the nearest approach to anything of that sort is: "noises or sounds of any kind," "vocal or other sounds." But, weak though this may be, the use of such general and feeble terms does not prove that Bell did not contemplate at that time the possible application of his "*new and useful improvements in telegraphy*" to the transmission of speech. It merely proves that Bell, on the 14th of February, 1876, was still far behind the point attained by Reis on the 1st of December, 1861. He was only fourteen years three months and thirteen days too late; and even then not abreast of that which Reis had accomplished without either attorneys or capitalists to back up his efforts.

SILVANUS P. THOMPSON.

September 5, 1885.

CAUSE OF THE ELECTRIFICATION OF CLOUDS.

WHEN the potential of an insulating medium increases as we recede from a conductor in its midst, this latter is negatively electrified; and this is the case with the air in fine weather, so that Peltier's *hypothesis* that the ground is normally covered with a layer of negative electricity can be shown to be a *fact*. Even if some portions of the earth's surface are positively electrified, as is indeed the case, they are so limited in extent as to leave the balance of the earth's charge of negative sign.

A cloud arising near the earth's surface may be in electrical communication with it, and so become negatively electrified, and on the dispersion of this cloud by evaporation the surrounding air would take up this negative charge. A cloud is a sufficiently good conductor to allow of the potential at all points in it being practically the same. If, then, a cloud is formed in an originally clear sky, this cloud will be electrified positively below, and negatively above. If, now, by the action of the wind the two portions of the cloud become separated, we have two clouds charged with opposite signs. Not only can this electrification by induction be shown to take place, but it may be further shown that the quantity thus produced is sufficient to account for electrical storms; for as the clouds rise their potential increases enormously, probably by one C.G.S. unit for each meter of elevation, so that the mere displacement of clouds may give rise to differences of potential corresponding to several thousand units.

The author, therefore, reduces the electrification of clouds to the existence of a negative charge of electricity on the earth's surface, which he considers to have always existed since its formation.—*H. Pellat, in Journal de Physique.*

CONSTRUCTION OF COPIES OF THE LEGAL OHM.

AFTER the Conference of 1884, at which the legal ohm was settled, the author was requested by the Minister of Posts and Telegraphs to make copies of the unit of resistance. This he was able to do with great accuracy, having placed at his disposal all the resources of the International Committee of Weights and Measures.

To calculate the resistance of a column of mercury, it is necessary to know (1st) the internal shape of the glass tube, (2d) its capacity, (3d) its length; we can then use the formula,

$$R=r\frac{l^2}{v}\left\{\left(\frac{1}{C+x_b-x_a}+\frac{1}{C+x_c-x_b}+\ldots\right)C^2+\frac{(n-m)^2}{n-m+x_n-x_m}\right\},$$

where r is the resistance of a column of unit length and unit section; l is length at zero of one division of the graduated tube; v the capacity of one division; a, b, c, etc., the several divisions; C the constant value $b-a=c-b=$, etc.; x_a, x_b the corrections to be made for the individual divisions.

In order to introduce the mercurial column into the circuit, the connections were made by means of large flasks full of mercury, into which the tube entered through lateral tubulures. This method of connection introduces an additional resistance which must be taken into account. It is obtained by adding to the length of the tube a quantity equal to 0·82 time its diameter. The coefficient 0·82, which had been deduced by Lord Rayleigh from theoretical considerations, has been experimentally verified by Mascart and De Nerville.

The author made use of four tubes, two of green glass, two of flint glass. They were all about 1·2 m. long, with a sectional area of 1 square mm., and were divided into millimeters for a length of 1·05 m. They had been prepared fourteen months before they were actually used.

The calibration of the bore of the tubes was most carefully carried out in the same manner as is done in the case of delicate thermometers, viz., by accurately measuring the length of a thread of mercury at various points of the tube.

To determine the capacity of one division of the tube, it was filled with a column of mercury 950 to 1,000 mm. long, which was in like manner measured in twenty different positions, allowance being made for errors in the size of bore as determined by the preceding operation, and also for the meniscus. The length having been thus most carefully ascertained, the mercury was emptied into a small glass vessel, and weighed with all the nicety possible with the very delicate instruments of the Committee of Weights and Measures. Adopting the value 13·5956 for the specific gravity of mercury, it was then easy to calculate the volume comprised between any two divisions of the tube. It was found that in the measurements of lengths it was sufficient to divide the tube into twenty-one sections, as this gave the true resistance within $\frac{1}{1000}$. Starting from the zero division, the exact length of each tube was determined which should have a resistance of one legal ohm, and by successive trials the tube was reduced to this length. The whole of the measurements having been made at the prevailing temperature of the room, the coefficient of expansion of the glass was obtained, and the corrections made to bring the values to zero.

The geometrical determinations having been completed, the resistances of the four tubes were compared electrically among themselves. The bridge was made up of three German silver wire resistances, each nearly one ohm in value, the fourth branch containing the tube under test. The apparatus was completed by a stretched wire with a sliding contact. A displacement of 1 mm. on the bridge wire caused a deflection of about 300 mm. on the scale of the galvanometer. The value of the bridge wire had been accurately determined beforehand, and it was found that 1 mm. was equivalent to 0·0009907 ohm. The comparisons were made between each pair of tubes by two observers, the author and Mr. De Nerville.

Admitting that the mean value 0·999994 ohm as deduced from the geometrical measurements is exact, the resistance of the four tubes comes out—

	Benoit.	De Nerville.
I.	1·000016	1·000020
II.	0·999996	0·999996
III.	0·999962	0·999959
IV.	1·000002	1·000004

More easily portable copies of these four standards have also been made in glass tubes coiled into a spiral; the ends being reduced until the resistance of the spiral was made accurately equal to one legal ohm.

With reference to the point of the purity of the mercury employed, Mr. Benoit remarks that after several tests it was found that mercury purified repeatedly by the action of hot nitric acid, then dried under a layer of concentrated sulphuric acid, and finally passed over caustic potash, was always directly comparable, from whatever source it might have been derived.—*Benoit, in Journal de Physique.*

THE LAWS OF FRICTION.

By MARCEL DEPREZ.*

THE purely mechanical part of one of the receiving machines designed for the experiment upon the electric transmission of power, which will take place before long between Creil and Paris, having been completed a few days ago, I was obliged to go and receive it, that is to say, to ascertain whether it was capable of revolving at the velocity of six hundred revolutions per minute for a whole day without any heating resulting therefrom. This condition having been fulfilled, I desired to measure approximately the work absorbed by passive resistances, which are in great part represented by the friction of the axles in their bearings. For this purpose I had a belt attached to the machine, and suspended therefrom weights that were increased until the machine began to move. It was ascertained in this way that a weight of 341 pounds, acting tangentially upon a pulley 17 inches in diameter, was scarcely sufficient to keep the machine in motion when it had been set running at a slight velocity. The diameter of the journals being 4·5 inches, and the weight of the movable pieces being 8,360 pounds, it is easy to satisfy one's self that the coefficient of friction is nearly equal to 0·15, and that the resistant work due to such friction rises to 1,595 foot-pounds when the axle of the machine is making a revolution. The normal velocity having to be 400 revolutions per minute, it results from these figures that friction will absorb about 11,000 foot-pounds per second.

This result approaches those that are daily being ascertained in the railway industry, where the coefficient of friction in the axle-journals lowers for the velocity of freight trains to 0·015.

Wishing to submit my results to a decisive control, and having no dynamometer at my disposal, I employed the following method: I gave the machine an increasing velocity, and, at the moment the speed reached about 600 revolutions per minute, I gave orders to allow the belt to fall that set it in motion. Then, a revolution counter having been applied to the shaft of the machine, I noted very accurately, every thirty seconds, the number of revolutions that it was making. I thus obtained the annexed table.

Time Marked by the Chronometer.	Number of Revolutions Marked by the Counter.	Mean Velocity for Thirty Seconds.	Second Differences.	Time Marked by the Chronometer.	Number of Revolutions Marked by the Counter.	Mean Velocity for Thirty Seconds.	Second Differences.
Seconds.				Seconds.		107	
0	0			600	3,486		5
		275				102	
30	275		15	630	3,588		5
		260				97	
60	535		14	660	3,685		5
		246				92	
90	781		14	690	3,777		4
		232				88	
120	1,013		13	720	3,865		4
		219				84	
150	1,232		12	750	3,949		4
		207				80	
180	1,439		11	780	4,029		4
		196				76	
210	1,635		10	810	4,105		3
		186				73	
240	1,821		9	840	4,178		3
		177				70	
270	1,998		8	870	4,248		3
		169				67	
300	2,167		8	900	4,315		3
		161				64	
330	2,328		7	930	4,379		3
		154				61	
360	2,482		7	960	4,440		4
		147				57	
390	2,629		7	990	4,497		4
		140				53	
420	2,769		7	1,020	4,550		5
		133				48	
450	2,902		6	1,050	4,598		6
		127				42	
480	3,029		6	1,080	4,640		9
		121				33	
510	3,150		4	1,110	4,673		9
		117				24	
540	3,267		5	1,140	4,697		
		112				Stop.	
570	3,379		5	1,154	4,702		

* In *La Lumiere Electrique.*

This table makes known the number of revolutions as a function of the time, and it is easy to deduce from it the angular acceleration, and, consequently, the retarding element due to friction. Let us designate by:

P, the total weight of the masses in motion,
ρ, their radius of gyration,
ω, the angular speed at the epoch, t,
K, the resistant work developed by friction for an entire day,
r, the radius of the journals,
f, the coefficient of friction,

and we shall have the following relations:

$$K=-\frac{2\pi}{g}P\rho^2\frac{d^2\omega}{dt^2} \qquad f=\frac{\rho^2}{gr}\frac{d^2\omega}{dt^2}.$$

In the machine under consideration, the masses in motion were reduced to, say, two homogeneous cast-iron disks 3·6 feet in diameter, weighing together 7,700 pounds. The steel axle weighed 660 pounds, but its motion of inertia was trifling with respect to that of the disk. The radius of the journals was 2·25 inches.

By reason of the slowness with which the velocity decreased, we may, without committing sensible error, replace the differentials by the finite differences, so that in definite we may say that the coefficient of friction is proportional to the second differences inscribed in the fourth column of the table. Now, these second differences (and this is the main fact that results from this experiment) vary from 15 to 3. Thus, then, in the experiment cited, the coefficient of friction diminished with great regularity at the same time with the velocity, and that its value varied in the ratio of 5 to 1, while the velocity fell from 550 to 145 revolutions per minute. From 145 to 120 revolutions per minute it remained sensibly constant, in order to increase anew very rapidly in measure as the velocity tended toward zero. As to the absolute value of this coefficient, it is 0·025 for a velocity of 550 revolutions per minute, and 0·005 for one of 145 revolutions.

However astonishing this figure may at first sight appear, it seems to me to be beyond dispute, being given the extreme regularity with which the readings made with the revolution counter succeed one another, and the fact that the machine revolved for 19 minutes and 14 seconds before stopping, thus making 4,700 revolutions in order to exhaust the initial live force. The *mean* coefficient of friction, calculated by taking these last figures as a basis, would be equal to 0·013.

THE PRESERVATION OF TIMBER.*

Report of the Committee of the American Society of Civil Engineers on the Preservation of Timber, Presented and Accepted at the Annual Convention, June 25, 1885.

The committee on the "Preservation of Timber" was appointed early in 1880.

Even before the gathering of statistics on forestry for the census of that year, it had become evident to engineers, from the increasing price and growing difficulty in procuring good timber, lumber, and railroad ties in many parts of the United States, that several of the sources of such supplies were being rapidly exhausted, and that as a measure of both private and national economy it would soon become necessary for us to resort to the artificial preparation of wood against decay, as had been successfully done for years in Europe.

The principal questions before the committee were to determine which methods of preserving timber against decay were most successful, and which were best adapted to the needs and current practice in this country.

Designing to base its report only upon well ascertained facts, the committee undertook to gather as fully as practicable the records of the experiments that had thus far been made in the United States, in order to compare them with each other, and with the results in Europe.

During the first year the committee accomplished but little. It had to overcome the public indifference which then existed on the subject, and the popular impression that probably no good would result from the investigation, as it was doubted whether there were any successful processes applicable to this country. It also had to ascertain where the much-scattered information desired was to be found.

This it was determined to do by circulars and correspondence, in order to find *who* possessed the data of past experiments, and *who* would be willing to impart them. For this purpose the committee issued some 2,000 circulars, with postal cards inclosed, on which a form of answer was printed. It corresponded with some 350 persons, gathered and studied some 55 pamphlets, examined 104 patents, and thus obtained the results of some 147 experiments, which are hereinafter tabulated and commented upon.

When this information began to come in, the committee found it very confusing. Not only were there the greatest possible differences in the opinions which were expressed, but the facts seemed to contradict each other. Apparently the same processes seemed to give different results, and these again differed from the European experience.

The committee, therefore, made a preliminary report to the Washington Convention in 1882, and asked for more time to ascertain how each experiment had been carried out, and to sift the evidence.

This was very tedious, both because there were few written records of these experiments and we had to rely upon personal recollections, and because the various persons who possessed such remembrance (and sometimes it required three or four to recollect the details of one experiment) had changed their business connection, and were scattered all over the country.

The committee here wishes to express its grateful thanks for the universal kindness and care with which its inquiries have been answered by the various gentlemen whose names will be found quoted as "authority" in the records of experiments (last column). Whatever value this report may prove to possess is due to their assistance.

NECESSITY FOR PRESERVING TIMBER.

The data on forestry gathered for the census of 1880 have made it apparent that the time has now arrived when railway and other interests must largely resort to the artificial preparation of wood, in many parts of the United States.

As something may be accomplished by economy in the use of timber and by preventing waste, the Washington Convention instructed the committee to include the latter subject in its report. This was intrusted to Mr. Francis Collingwood, who, from past researches and present inclination, was best fitted for the task, and who has furnished a monograph on the subject, which will be found in Appendix No. 1, and to which particular attention is invited.

From this it appears that our Northern white pine forests, which less than a generation ago were considered as inexhaustible, now bid fair to yield but eleven years more of supply at the existing rate, and that there is a growing scarcity of wood suitable for railroad ties.

These facts must soon produce advancing prices. The farther, but still accessible, supplies are now being drawn upon, and as soon as they are exhausted, prices will go up with a jump. Several such periodical advances have already taken place, and in the older States, lumber, timber, and ties are ruling at about double the rates prevailing thirty or forty years ago, with a prospect that in less than half that time they will approximate European prices.

Timber has hitherto been so abundant and cheap in the United States that there has been but little inducement for economy in preserving it artificially against decay. It was known that the Europeans, who have been experimenting on the subject for more than a century, had accomplished decided success; but inasmuch as to be effective the work must be well done, it was found here to be relatively too costly.

So long as wood was cheap, the cost of efficient preparation, including interest on plant and price of antiseptics, was so great in proportion to the ruling timber prices twenty or thirty years ago that timber preservation did not pay. It was cheaper to let it rot in the good old way, and many corporations and individuals, after trying experiments which were more or less successful, abandoned the work as not conferring benefits commensurate with the cost.

Fresh attention was attracted to the subject by the publication of Messrs. Colburn and Holley's report upon European railways in 1858. In this very valuable treatise a chapter was devoted to sleepers, and to their preparation against decay. This brought about the erection of some wood-preparing works by the larger railways, and a plentiful crop of so-called inventions to cheapen the processes.

The chief efforts of this crop of inventors were either to discover some cheaper antiseptics, or to use a less quantity than had been found to be requisite in Europe. They also proposed to reduce the time of application. These efforts to produce effects with cheaper agents, or to apply the homeopathic principle of small doses to the preservation of timber, did not meet with success. The inventors patented sundry preparations and methods, took such jobs as they could obtain, sold whatever State and county rights they could, and retired from the field when the insufficiency or danger of their process became apparent. We will hereafter describe some of these processes; and it may fairly be expected, should the publication of this report lead to renewed attention to the subject of wood preservation, that there will be a new crop of inventions based on the method of "how not to do it."

It will hereafter be seen that some of the processes which have been successful abroad led to indifferent or unsatisfactory results in this country. The committee has endeavored to ascertain the causes of this, and found them in the unobservance of some of the conditions which have been found necessary to success in Europe. These relate to the time occupied in treatment, to the methods pursued, to the strength and quality of the solutions employed, and especially to the fact that the Europeans chiefly operate upon seasoned timber, while we have generally operated upon green or freshly cut timber, which requires a different treatment.

These various points will be touched upon in describing the principal experiments which have been conducted in this country, and will be found fairly to account for whatever differences have been found in the results—differences so great as to have led many managers of important interests to doubt whether any method of wood preparation against decay could be said to be successful.

PRESERVING PROCESSES.

Although experiments in wood preserving now date back some centuries, and the list of substances experimented with seems nearly endless,* there are but few antiseptics which have stood the test of time, or have been worked commercially.

Special activity seems to have set in with the Railway Era, and the consequent demand for timber which had to be exposed to the weather.

Hundreds of patents were then taken out in England, and the committee has collected 104 issued in the United States. Few of them, however, have proved permanently successful.

Mr. W. P. Moir, in a paper read in 1869 before the Philosophical Society of Glasgow, gives the following list of the names of the patentees and the most valuable compounds employed:

Kyan	1832	Chloride of mercury.
Margary	1837	Sulphate of copper.
Bethell	1838	Creosote or pitch oil.
Bethell	1848	
Burnett	1838	Chloride of zinc.
Burnett	1840	
Boucherie	1839	Pyrolignite of iron.
Boucherie	1846	Sulphate of copper.
Payne	1841	Sulphate of iron.
Payne	1846	Carbonate of soda.

Concerning the modes of application, Mr. Moir says: "The methods employed practically in working these patents were three in number, namely, steeping, vital suction, and pressing in close vessels; Kyan and Margary employed the first mentioned method; Boucherie employed the second; and Payne, Burnett, and Bethell employed the third, which was also latterly adopted by Boucherie. The first and third methods required that the timber should be seasoned and free from sap."

These original patents have now all expired, and the use of the antiseptics which have proved most effective is open to the public. Whatever valuable patents have since been taken out refer chiefly to the modes of application, such as steaming in closed cylinders, to season the wood and remove the sap, and various devices to prevent the antiseptic from washing out upon exposure. Whether it will pay to use them each party will determine for himself; but it may be said in general terms that we now know the antiseptics which are most effective, and that the best modes of application are also pretty well known.

It will much simplify matters, for those who have not made a study of the subject, to group, so far as possible, the records of experience under the names of the best known processes, and to include therein various modifications which had sufficient of novelty to form the basis for a new patent. We have, therefore, classified the various experiments in the United States, concerning which we have been enabled to gather information, under the following heads:

1. Kyanizing—or use of corrosive sublimate.
2. Burnettizing—or use of chloride of zinc.
3. Creosoting—or use of creosote oil.
4. Boucherie—or use of sulphate of copper.
5. Miscellaneous—or use of various substances.

In referring to these experiments, we have endeavored to point out the causes of the success or the failure; and where full information seemed desirable, we give, in the appendix, the text of letters received by us over the names of their respective writers.

Many of these gentlemen took sufficient interest in the matter to hunt up and send to the committee specimens of the timber operated upon in these experiments. These specimens were exhibited at the National Exposition of Railway Appliances, held in Chicago in June, 1883, and are now deposited in the museum of the Civil Engineers' Club of the University of Illinois, at Champaign, Illinois.

KYANIZING.

As already stated, kyanizing was first introduced in 1832. It consists in steeping the timber in a solution of corrosive sublimate, probably the most powerful antiseptic known next to creosote.

The original proportions were one pound of the dry salt to four gallons of water, or a solution three per cent. strong by weight. Of this the timber absorbed six or seven pounds of salt per "load" of 50 cubic feet, or say ten to twelve pounds per 1,000 feet, board measure. As the price of this chemical was then $1.25 per pound, it cost some $12 or $14 per 1,000 feet, board measure, and this led to a more sparing use of it. Ultimately the solution was reduced to one pound to ten gallons, or even fifteen gallons, of water (1·2 to 0·8 per cent. by weight), and with the latter the timber absorbed about two and a half pounds of the salt per 1,000 feet, board measure.

It was also applied by the "Boucherie" process, but the timber was found to absorb too much of the salt, and some of the solution necessarily ran to waste. The cost induced some of the contractors to further reduce the strength of the solution. To speak in plain terms, it led them to cheating, and kyanizing fell into contempt in England. Moreover, the process is very tedious, because of the length of time required to impregnate the timber, and there are now but two private establishments in this country (which will be noticed further on) which kyanize timber for their own use.

At this salt now costs fifty to sixty cents a pound, and as an absorption of four or five pounds per 1,000 feet, board measure, is considered sufficient, kyanizing now costs about $6 per 1,000 feet, board measure. Where and when it will be profitable to use it will depend upon the price of the timber and its subsequent exposure; and in order to serve as a basis for forming conclusions on this subject, we have compiled the following table of sixteen experiments, which have been made in this country, and we add the comments which they seem to require.

COMMENTS ON KYANIZING EXPERIMENTS.

Concerning the first experiment in the list, General T. J. Cram says, in a report to the Chief of Engineers, made September 9, 1870:

"I have found our northern red cedar treated with the old Kyan process (an infusion of corrosive sublimate), after 22 years' exposure, lying on a slope of strong limy soil, to have gone to decay, especially the lower ends of the sticks; and kyanized white oak of Michigan, resting upon the same kind of dirt, dozed and rotted twenty years after the treatment.

"Chestnut railroad ties, grown upon the barrens of Maryland, kyanized and laid upon a limy soil, some miles north of Baltimore, in 1838, I saw tested 11 years afterward, and then perfectly sound and more solid than when laid; while those of the same kind of wood, untreated but laid at the same time, in the same kind of soil and exposure with the treated ones, lasted only 7 years before they required renewal.

"This experiment of kyanizing timber was the first, I believe, ever practiced in our country. Ties enough were treated for 1 mile of track, costing 12½ cents per cubic foot of timber. The process, however, was so unhealthy, salivating all the men, it had to be abandoned. It would be worth while to ascertain if those kyanized ties are yet sound. At that time the untreated ties cost only 14 to 16 cents."

Diligent inquiries among the present officers and some of the former officials of the Northern Central Railroad have failed to elicit any further information as to the final result of this experiment. It is very evident, however, why it was not followed up. Cross-ties usually contain from 2 to 3½ cubic feet of timber, which, at 12½ cents per cubic foot, would make the cost of treatment, at that time, from 25 to 44 cents per tie. This is wholly out of proportion with their original cost, which was 14 to 16 cents apiece. The same ties would now cost untreated about 50 cents apiece, and at the reduced cost of corrosive sublimate could be kyanized for 15 to 25 cents each.

* From the Transactions of the Society.

* In a treatise on the preservation of timber, by Wm. Chapman, civil engineer, published in London in 1817, will be found records of experiments with, and mode of application of, the following substances: Sulphate of iron, sulphate of copper, nitrate of silver, corrosive sublimate, sulphate of zinc, carbonate of soda, caustic soda, charring, arsenic, barytes, salt, quick-lime, alumine, selenite, soap, resin, mineral coal, charcoal powder, coal-tar oil, vegetable oils, fish oils, essential oils, vapors of oils, etc., which had been applied to the preservation of timber for ships, jetties, bridges, buildings, etc., etc. This, it will be seen, covers almost all the ground since traveled over by patentees, who are constantly even now experimenting with and patenting substances which had been investigated and discarded by Mr. Chapman and his predecessors.

RECORD OF SOME AMERICAN EXPERIMENTS.

KYANIZING,

Or use of a solution of chloride of mercury (corrosive sublimate).

No.	LOCALITY.	Year.	Process.	Material Treated.	Subsequent Exposure.	Results.	Authority.
1	Northern Central Railroad	1838	Steeping	Chestnut ties	Railroad track	Favorable to 1849	T. J. Cram.
2	Ft. Ontario, N. Y.	1839	"	Hemlock timber	Fortifications	Partial success.	W. P. Judson.
3	Chesapeake and Ohio Railroad	1840	"	Oak ties	Railroad track	Favorable to 1854	H. D. Whitcomb.
4	Alexandria	1840	"	Timber	Bridge	Success to 1862	W. R. Hutton.
5	Delaware and Hudson Canal	1842	"	Rope	Inclined planes	Abandoned	J. Archbald.
6	Baltimore and Ohio Railroad	1842	"	Ties	Railroad track	Not encouraging	J. L. Randolph.
7	Old Colony Railroad	1845	"	"	" "	Did not pay	I. Hinckley.
8	Eastern Massachusetts Railroad	1846	Pressure	"	" "	Cost too much	H. Bissell.
9	Providence and Worcester	1847	Steeping	"	" "	Did not pay	I. Hinckley.
10	Lowell Canal Company	1848	"	Timber	Bridges	Continued success	J. B. Francis.
11	New York Central Railroad	1849	"	Ties	Railroad track	Favorable to 1859	J. F. Wilkinson.
12	Philadelphia and Reading Railroad	1850	"	Pine timber	Bridges	Success	J. D. Steele.
13	Fitchburg Railroad	1853	"	Joists	Shop floor	Failure	J. Adams.
14	Blackstone Bridge	1854	"	Pine timber	Bridge	Success	W. H. White.
15	Boston and Providence Railroad	1856	"	Ties	Railroad track	Unfavorable	G. F. Folsom.
16	Eastern Massachusetts Railroad	1881	"	"	" "	Too recent	H. Bissell.

The records of a similar experiment (No. 3) on the Louisa, now Chesapeake and Ohio Railroad, are furnished by Mr. H. D. Whitcomb. It appears to have been successful up to a certain time, and then to have been lost sight of, probably because the cost of preparation was more than that of the ties.

Experiment No. 2, that at Fort Ontario, has been fully described in the paper of Mr. W. P. Judson, published with our preliminary report. After thoroughly investigating the results, Mr. Judson came to the following conclusions:

"An examination of this work indicates that kyanized hemlock (and probably Canada white pine also), if set up so that there should be a free circulation of air about it, away from contact with moist earth, and with its bases and joints so formed that water would not lodge in them, would be 80 per cent. sound after 40 years. The use of the process is not recommended for a work which will be liable to continuous moisture."

Mr. Judson, therefore, does not believe that kyanizing would be satisfactory for railroad ties, in view of the moist nature of their exposure, and his view is confirmed by the results of the experiments on the Baltimore and Ohio Railroad (No. 6) in 1842, on the Old Colony Railroad (No. 7) in 1845, and on the Providence and Worcester (No. 9) in 1847, which were all abandoned as unprofitable.

Concerning experiment No. 15, on the Boston and Providence Railroad, in 1856, Mr. G. F. Folsom, Superintendent of Construction, writes: "The ties were green and half-seasoned pine and spruce. After a few years' service the hearts of the ties were found decayed, while one-quarter to one-half an inch of the surface was as sound as when laid under the track."

Concerning experiment No. 11, on the New York Central Railroad. Mr. J. F. Wilkinson, of Syracuse, N. Y., says: "In 1849 a quantity of hewed hemlock cross-ties were charged with the solution of corrosive sublimate, I think by immersion in vats prepared for this purpose. In some alterations that were made in the track of the road, a large quantity of these ties were taken up after four years' use in the main track, and about 2,000 of them were laid in the branch tracks at Oriskany Station. In 1859 I examined the ties in these branches, and found that there was comparatively little decay among them. I do not remember how long it took to prepare these cross-ties. I think that at the time it was estimated to cost about ten cents each. There were certainly several years added to the duration of the cross-tie."

Mr. J. B. Francis, Past President of this Society, gives kyanizing preference over other processes; he has been working with success since 1848 (experiment No. 10), and has furnished the committee the interesting account published in Appendix No. 2.

He informs us that he chiefly uses the timber kyanized at Lowell for bridges over the canal, and that although he has repeatedly prepared experimental ties for the neighboring railroads, none of them, save the Eastern Railway of Massachusetts, have adopted the process.

For bridges, or for timber exposed to weather alone, and not to constant moisture, there seems to be no question as to the beneficial effects of kyanizing. This is markedly shown by the record of experiment No. 4, on the Alexandria aqueduct, at Georgetown, D. C., where nine spans of Burr truss bridge stood from 1840 to 1862, and failed even then, not from decay, but from defects in construction.

It is also shown by the record of experiment No. 14, at the Blackstone River bridge, on the New York and New England Railroad, which consisted of a Pratt truss, built and kyanized in 1848, and which, although much overstrained by the increased weight of rolling stock, was found, when taken down in 1876, after twenty-eight years of exposure, almost entirely undecayed. Even the foot of the posts, which rested upon oak blocks, were perfectly sound.

A like success attended the kyanizing on the Philadelphia and Reading Railroad of two bridges in 1850 (experiment No. 12), the timber of which remained sound for at least twenty years.

Where, however, timber is exposed to moisture, kyanizing is of doubtful utility. On the Fitchburg Railroad in 1853 (experiment No. 13), the floor timbers for an engine house at Charlestown were kyanized, "because the location was very damp." They were found, however, a few years afterward as much decayed as if they had not been so prepared.

This experience is confirmed by the appearance of a number of kyanized spruce planks, laid in gate boxes on the Lowell water works, and kindly taken up to send to the committee by Mr. Geo. E. Evans, City Engineer. Where these planks were in dry places, they are quite sound after twelve years' exposure, and the life of the wood has been at least doubled. Where they were in wet places, they are decayed, and the amount of decay seems to be in proportion to the dampness of the situation.

From the foregoing, it seems pretty evident, that for bridges, trestles, fences, and similar exposures, kyanizing is a good process to use, and may safely be relied upon to preserve the wood twenty to thirty years; but that for cross-ties, pavements, and work exposed to constant moisture, success is more doubtful, probably in consequence of the washing out of the corrosive sublimate.

There are now two establishments for kyanizing in the United States. That at Lowell has been referred to in the letter of Mr. J. B. Francis. It consists of two pits or tanks, built of masonry, and lined with wood, each 49 ft. long, 7 ft. 4 in. wide, and 4 ft. deep, capable of holding 10,000 ft., b. m., of timber. The sticks are handled in and out by cranes, which also serve to swing large stones that are placed on the wood to prevent it from floating up. It is allowed to steep one day for each inch in thickness of its least dimension, and one or two days in addition. The solution used contains one per cent. by weight of corrosive sublimate, and from four to five pounds of this are absorbed per 1,000 ft., b. m. At a cost of fifty-three cents per pound, this comes to $2.12 to $2.65 per M., b. m., for chemicals, and as the labor costs about as much more, the total cost may be said to be $5 to $6 per 1,000 ft., b. m., exclusive of interest on plant and on timber in process of preservation. Some work is done for outside parties, for which $7 per 1,000 is charged, this being supposed to cover a small profit, enough to pay interest on the plant.

The other establishment is on the Eastern Railroad, at Portsmouth, N. H., and an account of this, together with a description of experiments Nos. 8 and 16, will be found in the letter of Mr. H. Bissell, Engineer of Maintenance of Way, in Appendix No. 3.

From this it will be seen that the Eastern Railroad, having resorted to kyanizing in 1846, by the unusual process of forcing the solution into the wood, in a cylinder, subsequently abandoned it, but has taken it up again for the preparation of its ties by the steeping process.

Too short a time has elapsed since 1881 to judge of the results, but the data gathered by your committee indicate that where these ties are laid in dry places (on stone ballast for instance), their life will be materially increased. Where they are laid in wet places, it is doubtful whether the benefit will be commensurate with the cost.

(To be continued.)

THE USE OF IMPERVIOUS COVERINGS ON FLOORING OF WOOD.

AT the present moment considerable attention is being given to the subject of impervious coverings on flooring of wood, and the admitted hasty decay of the same has raised the question whether it is traceable to want of ventilation on the underside or to the covering on the upper face.

The use of wood as a ground-floor material is matter of recent history, flooring of brick or stone being general in former times. During the last quarter of a century wood, from the abolition of the duty, and the introduction of machinery, has been cheapened to such an extent that it is no longer a luxury for flooring, but the cheapest material that falls to the hands of the builder.

It is an undoubted fact that free ventilation on the underside of wood flooring is beneficial to its preservation; but whether the flooring is sealed down on the upper side or not with floorcloth, kamptulicon, etc., it is subject to decay in the warm or summer season, for there is invariably sufficient moisture and heat to propagate fungi, of which family the destroying agent of wood is a member.

In the last century the belief was general that groundfloors in wood could be preserved by the spaces between the joists being leveled up with dry or quicklime. We have seen flooring so laid on oak joists in use for over a century, and when removed to be in fair condition, but only in the instance of their being laid over brick arches covering basements. If this system was followed in floors immediately over the soil, the result would not be satisfactory. Nevertheless, lime in proximity to wood, if kept fairly dry, is a preservative of no mean order, proof of which is afforded by plasterer's laths, timbers built in walls, and vessels used in the lime trade.

With regard to the free ventilation of the spaces beneath wood flooring, this is rarely necessary in floors above the ground level, as moisture is not present in these cases in sufficient volume to propagate the dry rot fungus. In the instances of ground floors, free ventilation often becomes an evil to the inmates of the houses, in the air passing through the flooring, skirting, and other woodwork to the interior of the rooms, and rendering them so cold in the winter season that the fires have little power in warming the apartments. This evil may be remedied by the ventilators being closed in the winter, for there is no fear of the wood decaying at this cold season.

Free ventilation, as we call it, is not always insured by air-grates below the level of ground floors, for the air may become so charged with moisture in these confined spaces that it will not, owing to its weight, move in the manner intended by the builder. There is a tendency in cold, humid air to occupy a low level, and it is not a safe rule to rely upon side ventilators to deal with such strata. An excellent plan for dealing with the air beneath basement floors is to build up, along with the chimneys, flues for its extraction.

The use of impervious covering on the face of ground floors is to be condemned. Wood is a porous substance, and the air beneath is constantly passed through the boards, being drawn by the more rarefied character of the air in the apartments above. The same action obtains with upper floors, and ceilings beneath the roof, lath and plaster offering no impediment, so long as it is not painted. In proof of this you will find in ceilings not regularly whitened the spaces to be dark, owing to the soot-laden air being filtered as it passes through the plaster, whilst the plaster covered by the joists above is light, and hence the white marks across old ceilings indicating the lines of the joists.

That moisture does pass through such floors we can give proof in the case of a first floor of some property which had been erected over fifty years. The ground floor was used as a cooking and work kitchen. This floor was covered with oilcloth, by which the air was prevented from freely passing through the ceiling and the floor boards. The boards themselves became damp on their undersides and swelled, which caused the lines of the joints to rise on the upper face, and the floorcloth to present a series of ridges and furrows, every joint of the flooring being clearly marked.

We had our attention called to the wood floors of an Exchange building where the basement was used as a restaurant. Between the joists, at certain points, steam-pipes were fixed under grating for warming purposes, the face of the board being covered with kamptulicon; there, in the winter season, during which, under ordinary circumstances, the flooring would be safe, dry-rot fungus was engendered, and to such an extent did it propagate that in four years, owing to the presence of heat and moisture, the floor was destroyed. A new floor was laid, and the system of impervious covering was abandoned, since which no sign of dissolution has presented itself. The reason of this is to be found in the fact that with the impervious covering removed, the heat, in the absence of confined moisture, was unable to propagate wood fungus or dry rot. In the instance of ground floors, dry rot will present itself if the boards are sealed down with impervious covering; the natural tendency of the moisture of the ground to rise through the boards is here retarded, and the side ventilation is not sufficiently effective to prevent the growth of dry-rot fungus.

The life of such a floor will vary with circumstances. Its dissolution will not be so rapid as when associated with artificial heat in the form of steam-pipes; but if the subsoil be clay, and the space between the soil and the board is not great, the floor would require to be renewed every six or seven years. If the subsoil was dry in its character, and the space between the soil and the board ample, a double lease of such life might be given, but ultimate dissolution could not be unlooked for.

We have an instance before us of a new floor in a new building, such floors being covered with kamptulicon being destroyed by dry-rot in six or seven years. A second floor has been put down, and the covering discarded. The floor of an adjoining room which has not been covered with kamptulicon shows no signs of decay. The dissolution is thus clearly traceable to the use of impervious covering. The investigation of this subject brings to light the fact that impervious coverings for wood floors are to be condemned, and it affords a clue to the unhealthful character of certain dwellings, for plaster ceilings and wood floors offer no guarantee against bad or impure air from bad ground, decomposed wood, faulty drainage, etc., rising into the apartments and polluting the atmosphere breathed by the inmates.

As a reform in the building trade connected with the immediate future we may look for great attention being given to the subject of damp courses, damp layers and block paving in wood, by which the damp of the ground is prevented from rising into the interior of the building, and air-spaces beneath floorings of woods are rendered unnecessary.—*Building News.*

RAMIE.

ON the evening of July 21st, a lecture on Rhea Ramie, popularly known as China Grass, was delivered at the Manchester Technical School by Dr. Forbes Watson, late of the Indian Office. Sir J. C. Lee, a member of the Council of the Technical School, presided, and there was a fairly large audience. The chairman stated that the Council lately received an offer from Dr. Watson to lecture in Manchester upon rhea ramie, and, as one of the functions of the school was to afford every facility for the discussion of any new question that might come up, the Council very gladly accepted his offer. Some three or four months ago, he (Sir Joseph Lee) brought the subject under the notice of the public of Manchester. He did so entirely on public grounds. Although his name had been prominently brought forward in connection with various companies and enterprises for the growth of ramie, he had nothing to do with them. He was only acting in the matter because he believed that the fiber would have a great part to play in the future. It was, however, no new fiber. From investigations made upon mummy-cloths in various museums, he found that rhea ramie was known to the Egyptians some 2,000 years B.C. He thought also that it was the fiber mentioned in the Book of Proverbs under the name of silk. The difficulty with it was in the process of ungumming, which had made it for 2,000 years a sealed fiber.

Dr. Forbes Watson, who had thoroughly investigated the matter in India and elsewhere, was perhaps better qualified to deal with the subject than any other man in the scientific world. Dr. Forbes Watson began his lecture by exhibiting and describing specimens of the plant, some of which had been grown in Hampshire. There were, he said, two principal species of the plant which supply the China grass of commerce. In the one the leaf is green underneath, and in the other white. The first operation required was to strip the plant of its leaves, which afterward formed a manure. When the plant was perfectly green, the whole of the fiber could be got off. When it became brown at the bottom, the plant was sufficiently ripe and ready for cutting.

The next process was to strip off the bark containing the fiber and scrape it clean with a knife, the latter operation being a very slow one. The fiber thus ob-

tained had in it a very considerable proportion of its gums, ranging from 22 to 35 per cent., the average being about 28 per cent. These gums represented the refuse matter, which had to be got rid of. Only a small quantity of fiber, therefore, could be obtained by this manual process. In China he believed the quantity obtainable per diem by one person was from ½ lb. to 2½ lb., the latter amount being the extreme. The average was 1 lb., but in India unskilled hands produced only a few ounces, certainly not more than ¼ lb. Therefore it would be impossible by this method to carry it out as a remunerative industry. He had determined by experiment that from 3½ ft. to 4 ft.—certainly not more than 5 ft.—was the most suitable height to which the plant should be grown. Dr. Watson next exhibited a specimen of rhea ramie grown in India, showing the result of stripping off the fiber without taking off the brown bark. It was possible, he said, that this might become an article of commerce, the difference between it and the China grass being difference in degree as to the amount of refuse matter in it.

Another specimen was then shown, in dealing with which the stripping of the bark had been partially performed by the action of steam. In this—known as the Favier—process the stems were laid in boxes into which the steam was admitted for from 15 to 25 minutes, after which it was found that the stripping could be performed with much greater facility, especially if the plant was old, when indeed it could not be completely stripped by the hand alone. The effect of the steaming, however, was to draw out and coagulate certain of the juices, which set their coloring matter on the fiber, and they got from the process the harsh material seen in the samples. He doubted, therefore, whether the steaming was a beneficial operation. Speaking of the mechanical methods of obtaining the fiber, the lecturer exhibited specimens of the fiber not from dried stalks. In a report he made to the Government of India on the question, he pointed out the importance of getting the fiber from dried stalks. The reply made to him was, "That is all very true if you can dry the stems," which contained between 80 and 90 per cent. of water.

It was impossible, except by most expensive artificial means, to dry those stems at the seasons of the year when the best crop was grown. The gums of the plant were very liable to ferment or run into mould, and the Government therefore still wanted a machine which would deal with China grass in a green form. It had for many years been the object of the Government to find such a machine. This was by no means easy, but on an examination of Death and Ellwood's machine he had come to the conclusion that it would clean the stems with an infinitesimal loss. The problem had been solved how to get the small proportion of bark, with its embedded fiber, out of the stalk. The green stems were put into the machine, and with the aid of a stream of water underneath, forming a sort of cushion, on which the fiber was supported during the operation, it was in many cases turned out in a pure white condition. Under ordinary circumstances from 15 to 20 per cent. represented the proportion of gum in the fiber prepared by that machine, as compared with a percentage varying from 25 to 35 in the case of China grass.

A great deal of the quality of the fiber depended on the condition of the plant in respect of growth. For one thing, it must not be too old. With reference to the important question of the amount of waste, Dr. Watson said that careful experiments made at Calcutta and elsewhere showed that the proportion of waste was very small indeed, and that any waste there was could be worked up. The cost of production of the fiber varied from £4 to £7 per ton. The China grass, as imported, was a fiber that was extremely easily prepared for manufacturing purposes. The great thing in preparing all those fibers was to endeavor to get it into the condition which would give the largest proportion of long fiber. In the form of noils it was only worth 6d. or 7d. per lb., but the long fiber fetched from 1s. to 2s. 6d. per lb., and sometimes even more. Any good process should at all events yield 50 per cent. of long fiber; the remainder would be noils. Every one of the fibers must be prepared by a chemical operation, and the question was as to which operation was best.

The Fremy-Urbain process, as employed in Paris, he looked carefully into some time ago, and the conclusion he came to was that it was a very imperfect process as regarded the quality of the fiber turned out. Since that time, however, he understood that a great improvement had been effected in the process. In conclusion, Dr. Watson asked what had now to be done with regard to China grass? He believed that the people had now got a grip of the matter, and were likely to hold on, and that we were on the eve of seeing an industry in China grass which would go on. All that was wanted was the stuff. He questioned whether at the present time twenty tons of fiber could be got out of all the rhea which was growing in Europe; forty certainly could not. If the industry was to become a large one, the plant must be cultivated to a much greater extent than at present. Those who had ground, and wanted to turn it to account, might with confidence go in for the cultivation of the rhea. He believed there could be no doubt with regard to its capabilities.

Death and Ellwood's machine was shown in operation during the lecture, which was also further illustrated by the exhibition of some beautiful fabrics made on the Continent from rhea ramie. In answer to a question put to him, Dr. Watson said that none of the plants had produced fertile seeds in India. They were grown from seed introduced from the West Indies.

Mr. C. E. Collyer (London) said he had a large quantity of the seed which he could sell, but he did not know where it was got from. Mr. Sansone, Master of the School of Dyeing, in proposing a vote of thanks to Dr. Watson for his lecture and for the specimens and samples exhibited, which the Doctor had presented to the Technical School, said that he thought the treatment of the plants was only suitable for large undertakings in which machines could be employed. For small cultivators—peasants with only a bit of ground, and who could not put up a boiler or machine—a process which would deal with the dry stems would be advantageous. He agreed with Dr. Watson that there was a difficulty about the dry stems, but they could be well treated when quite dry. By whichever way the fiber was obtained, it would always have to undergo a chemical process. When just from the stems, it certainly was not fit for dyeing or bleaching, and it must therefore undergo such a process. There were various processes, and in many of these caustic soda and acids were employed. The merit of any process was not in the materials used, but in the happy combination of different operations. While he did not consider the Fremy process perfect, he had not seen a better method for the ungumming of the fiber. Every one could ungum small specimens in his laboratory, but it was a very different matter when dealing with large quantities; and if we had even now only forty tons of material all over Europe, it meant that nobody had yet been successful enough, otherwise we should have had Liverpool stocked with China grass.

FRENCH ARCHITECTS AND WORKMEN.

IN the Congress of the French Architects, prizes were given to students, contractors, and workmen. The issue of the paper which was read on the occasion by the sympathetic secretary, M. Paul Wallon, shows that the prize-winners were "representative men" in the truest sense of the phrase, and the notices of their careers will help us to understand something of the condition of architecture and building in France, as seen from one point of view.

Among the prizes precedence was given to those which were awarded to the architectural students, and two medals were obtained by students of the French school at Athens. Subscriptions are being raised in England to found a British school in Greece; but characteristically the ambition of the promoters is to enable students of the classics to be in a place which will enable them to understand more clearly the books they have read, and where they may occasionally indulge in a little aimless excavation. The French are as thrifty in archæology as in cookery, and when they expend money on anything they endeavor to extract as much benefit from it as its nature will admit. Greece is to them something more than a hunting-ground for fledgeling connoisseurs. It is a place where artists can receive education of the best kind. Accordingly we read that when one prize-winner, M. Paris, made explorations on the site of the Temple of Minerva Kranaia, at Elatein, it was with a view to an attempted restoration of the building on paper. If an English student accomplished similar work, his ambition would be crowned if he afforded a new subject for conversation in a college common-room, or in Albemarle Street. The second student who was rewarded, M. Laloux, spent five months at Olympia, and produced the fine drawings of the temple which obtained the highest honors awarded to an architect in the Salon of this year.

The Societe Centrale des Architectes has a surprising power of uniting all kinds of societies and institutions with itself, as if it were a sort of keystone in the fabric of art. The national academies in Rome and Athens accept the medals of the Societe as proofs of excellence which could not be disputed. They are honors which raise the essays at restoration out of students' work. In the same way the prizemen of the Ecole des Beaux-Arts and the Ecole des Arts Décoratifs are glad to be recognized by architects as judges who are not to be deceived by pretty drawings. An effort is made at the distribution to enable the student to feel that he is not entirely a stranger; if he has had a teacher or a relative who belonged to the society, it is sure to be announced. The secretary was therefore glad to say, and the members no less glad to hear, that MM. André and Louvet, who gained the prizes founded by the late M. Destors, were the sons of two members of the society who are professors at the Ecole des Beaux-Arts, and have been holders of the Prix de Rome. It will be seen from our announcement last week that M. André has won the Prix de Rome this year, while his companion has gained a second prize. Their success bears out the remark of Mr. W. H. White about the heredity of talent among French architects. A third prize-winner from the same school, M. Margotin, is the son of a sculptor and ornamentist who has gained repute in Paris. Another student, M. Garnier, who did not come from any of the public schools, was a remarkable example of success. Although he had been only ten months in Paris, it appears he won three medals and seven honorable mentions. M. Wallon might safely foretell a prosperous future for so able and industrious a youth, who must be possessed of strong will and concentrative power to be so absorbed amidst the distractions of Paris life.

To English ears it will no doubt be a suggestion of disparagement when we say that the Societe Generale is not rich in money, and that it is indebted for annual medals to the generosity of individual members. The Government did at one time grant a modest convention, and then withdrew it without offering an explanation. M. Paul Sédille, who is skillful in turning new processes to account, founded one of those medals in 1877 as a reward for exceptional excellence in some art industry connected with building. This year it was awarded to M. Martin, a chemist, who set up a manufactory of mosaic, in order to make France independent of foreign artists and processes for that kind of work. He analyzed Roman examples, studied in the workshops of the Vatican, and spent days before the great mosaics; but, in spite of all his preparations, his first efforts were not profitable. In 1878 he made so much progress that he obtained a medal for his collection of tesseræ, which then represented 2,000 different tints; it has been extended since to 4,926, a quantity by means of which gradations of color to any extent can be copied. M. Martin is ambitious to excel the Italian mosaicists, and he has opened an *atelier* at St. Denis, in which he employs picked youths from the communal schools. He has been able, without the assistance of an Italian workman or an Italian tessera, to execute works for M. Garnier, M. Sédille, M. Lameire, and other architects and artists. The minister of fine arts has ordered from M. Martin's *atelier* all the tesseræ which may be required for the mosaics in the Panthéon and the Louvre.

Apprenticeship is dying out in France, and substitutes have been found in the municipal and technical schools of Paris. One which is closely connected with building is the Ecole Diderot, for instruction in wood and metal working. In addition to workshop practice there are classes for teaching English and French, drawing, mathematics and chemistry, physics, mechanics, technology, history, geography, and ordinary law. The students are all *externes*; they are admitted between the ages of thirteen and sixteen, and are taught gratuitously for three years. Afterward it is the care of the direction to place the students in workshops where they may have opportunities to become skillful handicraftsmen rather than assistants to make up for the deficiency of machines. The Societe Centrale could not allow an institution to be overlooked which is to exercise so much influence on the building trade of the future. Accordingly medals have been assigned to the students who are most successful in the competitions of the second and third years.

A school of different kinds and more under the control of architects is that of the masons and stone-cutters, which has evening classes in geometry, projections, and stone-cutting. It has always an architect for president. The silver medal was awarded to a mason named Dourieux, now employed at the works of the new Sorbonne, and the bronze medal to Jules Textier, whose success in geometry has given satisfaction to his teachers.

The Societe offers rewards to men who have gained distinction in something else besides studies. The *personnel du batiment*—that is, contractors, foremen, and workmen—are entitled to medals as well as the pupils. The principal medal was given to M. Frederic Bertrand, who has a claim to be considered a model Frenchman. He is a contractor for carpenters' work in Paris. M. Bertrand was taught by his father, and soon acquired a reputation for skill. He settled in Paris in 1851. In the Chambre Syndicale des Entrepreneurs de Charpente he held the office of secretary, and was vice-president for twenty years. Since 1874 he has been annually elected as president, and in 1882 a gold medal was struck in his honor. He is also president of the united building societes of Paris. The assurance society which is connected with the Chambre, for the purpose of meeting losses arising from accidents to workmen, was started by M. Bertrand. It was through his influence that the strike in the building trades was arrested in 1881. M. Bertrand has obtained medals from various exhibitions; he is a chevalier of the Legion of Honor, and his patriotism during the siege has been duly recorded. A second medal was awarded to M. Antoine, a contractor for joinery in Lyons, and who for nearly forty years has held a foremost place in a city which prides itself on its builders.

A medal was founded by M. Leon Salleron to reward foremen who have been at least ten years under one employer. It has been found that the time is too limited to be taken as a test, and men who can show their fidelity during periods varying from thirty to forty-eight years appear as competitors. The "constant service of the antique world," which Shakespeare supposed was at an end, is not quite extinct in France. It was so difficult to make a selection that two medals had to be awarded. One was to the foreman plumber who since 1848 has looked after the Theatre Francais and the remaining buildings of the Palais Royal.

M. Bellais is seventy-five years of age, he has been foreman in one house for forty-seven years, and still wishes to show he has service in his limbs. A medal from the Society was granted to M. Ferry, an Alsatian, who is one of those contractors' men who are said to have as many lives as cats. He is given charge of constructive ironwork, and is selected always for the post of danger. M. Ferry has fallen from great heights. Some of his fingers have been amputated, his bones have been dislocated, and his wounds cannot be reckoned. But he has shown a disregard of his own pain in order to render aid to his fellow sufferers. What is even more remarkable in these days of employers' liability, he has never sought to put the responsibility for his mishaps on anybody else, nor sought to find parmaciti for inward and outward bruises in heavy damages.

But in the annals of the poor which M. Wallon records there are many lives worthy of notice. One confidential foreman mason could not read or write when he went to his present master. He was taught, and rewarded the interest taken in him by nearly forty years of loyal attention. A second served for forty-three years, a third for thirty-seven, and so on. M. Vaudremer recommended a carpenter who really loves his work, and has exhibited all the virtues for twenty-eight years. The Societe des Architectes of the Alpes-Maritimes represented the merits of M. Amyot, a foreman carpenter. He served his time in Dijon, worked for seven years in Paris, and then settled in Nice. He taught descriptive geometry in the professional school of that city. Afterward the Minister of Instruction promoted him to the Ecole National d'Art Decoratif; but while attending to his classes M. Amyot does not renounce the bench. Plumbing was represented by a Corsican, who has remained in the same establishment during forty-four years. There were three joiners; the shortest service among them was twenty-one years. A *fumiste*, or chimney constructor, was forty-five years with the same contractors, and a marble mason was thirty-two years.

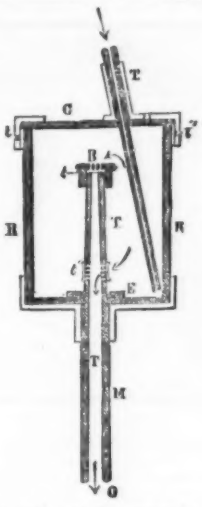
M. Wallon asked his auditory whether it was not touching to see, in the midst of countless temptations, so many examples of integrity to duty—men who, while suffering privations, were always true to themselves; and while some of them had no assurance of more than daily bread, they never forgot to look after the education of their children. It was a laudable office that was undertaken by the Societe Generale des Architectes when workmen were first sought in order to be distinguished by the bestowal of prizes in public, for their meritorious devotion to duty. Here we have not reached that degree of interest in others, and the carpenters and masons of England would, it is alleged, be indifferent to so simple an honor as a bronze medal unaccompanied by drink money. But, as in other things, the great difficulty is in a commencement, and who knows if the Institute might not insure more stability if it imitated the Paris Society in recognizing the existence of the men who give material form to the designs of architects?—*The Architect.*

A WRITER in the *Medical Press* (October 1, p. 292) gives a formula for a mixture for the cure of piles, from which he has, in his own experience, found great benefit, and which, for the benefit of those who do not see that journal and who may be asked for the mixture, is reproduced here: Potass. bromid., ℥ ij.; ext. ergotæ liq., ℥ ijss.; tr. nucis vom., ℥ j.; sp. am. arom., ℥ jss.; aq., ad ℥ viij. M. Sign. ℥ j. four times a day.

APPARATUS FOR PREPARING SOLID CARBONIC ACID.

IN the *Bulletin de l'Association des Eleves de M. Fremy*, we find a description of a new apparatus for preparing solid carbonic acid. It is due to Mr. Cailletet, and consists of a hollow cylinder closed at the base. A plug, provided with an inclined tube, is fixed to the orifice by means of a bayonet catch. This tube runs to within a fraction of an inch of the bottom of the cylinder, to which is affixed another tube designed to serve as a handle to the apparatus, and to allow the uncondensed carbonic acid to escape to the exterior.

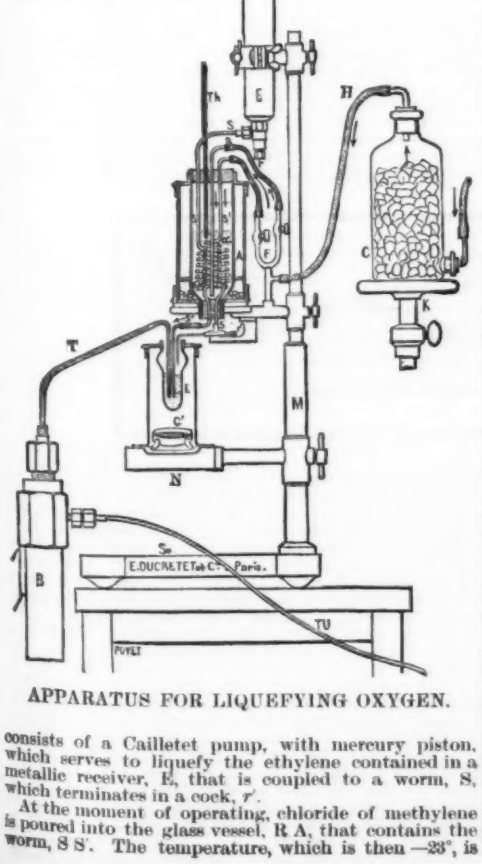
The entire apparatus is made of ebonite, which is a poor conductor of heat. Various experiments have given as a result 2 ounces of snow per 6 ounces of liquid used. A much greater yield can be obtained by adapting to the receptacle that contains the liquefied acid a copper worm of say one-eighth inch internal diameter. The lower extremity of this worm is closed by a conically pointed cock. The cock of the receiver being wide open, and the worm being cooled in a mixture of salt and ice, or in chloride of methyl, it is only necessary to open the cock of the worm in order to obtain in a few instants a sufficient bulk of carbonic snow to fill the apparatus.



This process of cooling, applied to ethylene and formene, gives excellent results, and differs essentially from the process that consists in passing partially expanded gas into a narrow tube. In the arrangement adopted by Mr. Cailletet, the worm forms part of the receiver, and the cooling of it in order to effect the condensation is precisely as if the receiver that contains the compressed gas, and is often bulky, were itself cooled in its entirety, a thing which it would be almost impracticable to do in cases where carbonic acid or ethylene is employed. When carbonic acid snow is being prepared with this apparatus, it is found that numerous electric sparks jump from the metallic pieces that surround the plug, the friction of the particles of carbonic acid against the ebonite producing electricity, as do the drops of water in the Armstrong machine.—*Le Genie Civil.*

APPARATUS FOR LIQUEFYING OXYGEN.

THE apparatus shown in the accompanying engraving is designed for liquefying oxygen by means of ethylene rapidly evaporated by a current of air. It



APPARATUS FOR LIQUEFYING OXYGEN.

consists of a Cailletet pump, with mercury piston, which serves to liquefy the ethylene contained in a metallic receiver, E, that is coupled to a worm, S, which terminates in a cock, r'.

At the moment of operating, chloride of methylene is poured into the glass vessel, R A, that contains the worm, S S'. The temperature, which is then —23°, is rapidly lowered to —70° by forcing dry air into the vessel, C, through the glass tube, *a*. As the cock, r, is open, and r^1 is closed, the ethylene thus cooled fills the worm, S, and, when the cock, r, is opened, flows without perceptible loss into the vessel, L, which contains air dried by the sulphuric acid in C'. The worm, S', serves for cooling the quantity of air regulated by the cock of the bent tube, F. Through its passage into the ethylene, this air depresses the temperature to —125°, that is to say, to below the critical point of oxygen.

The oxygen to be liquefied is contained in a test glass inclosed in the pressure reservoir, B, which is connected with the force pump through the tube, T U. When the pressure to which the oxygen is submitted reaches 50 or 60 atmospheres, it is observed to liquefy under the form of a colorless fluid having a well defined meniscus. This transparent liquid fills the small reservoir of the bent part of the oxygen tube, T, that dips into the liquid ethylene.—*Le Genie Civil.*

A METHOD OF PRODUCING OZONE IN LARGE QUANTITIES.

By ANDREW H. SMITH, M.D., New York.

THE question as to whether ozone has any therapeutic value is still unsolved, owing probably in a great degree to the difficulties of production in quantity sufficient for satisfactory experimentation. An observation made by the writer in December, 1883, seems to open a way by which these difficulties may be overcome, and ozone produced with sufficient readiness to permit the study of its physiological and therapeutical action on an extended scale, and also its remedial use, if it should be found to possess curative properties.

Cotton wool, when deprived of its oil as in the preparation of "absorbent" cotton, is a sufficient conductor of static electricity to secure the diffusion of that agent through a considerable mass of the fiber placed loose between the prime conductors of a static machine. If the experiment is tried in a darkened room, the cotton assumes the appearance of a luminous cloud. A large

surface of air contained in the cotton is exposed to the electrical action, and a corresponding amount of ozone is produced.

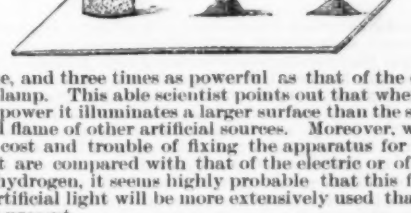
The apparatus which I have had arranged as the result of the above observation consists of a glass cylinder ten inches long by five inches in diameter, and having a narrow neck at each extremity, through which a brass rod is passed connected with the respective prime conductor and terminated by a base. On one side of the cylinder and midway in its length is an opening an inch in diameter, and provided with a lip for the attachment of the inhaling tube. The cylinder is loosely filled with absorbent cotton, and the balls attached to the rods from the prime conductors are introduced a short distance through the necks. The current is thus made to traverse the cotton, and when the machine is operated in the dark, the whole interior of the cylinder becomes luminous. The air drawn through the tubes is supplied by the openings at the ends of the cylinder, which are much larger than the rods which pass through them when a four plate Holtz machine is employed. This air is so highly charged with ozone that it must be inhaled with caution. If breathed incautiously, it excites cough and produces a disagreeable irritation along the respiratory tract, and especially at the bifurcation of the trachea, which irritation may continue for several hours. Persistence in the inhalation would, no doubt, be followed by congestion or inflammation of the bronchial membrane.

The remarkable power of ozone as an oxidizing agent has led to the idea that it might be utilized in the treatment of disease, especially of a septic character. No definite results, however, have been attained as yet.—*Medical Record.*

THE NITROUS OXIDE AND CARBON DISULPHIDE LIGHT.

By WM. THOS. JACKMAN, M.R.C.S., etc.

THE light obtained by burning a mixture of nitrous oxide gas and the vapor of carbon disulphide is well known to be very powerful for photographic purposes. It is of an intensely blue color, and very active in photographic-chemical properties, being, according to Stein,* twice as powerful as that of the oxyhydrogen



flame, and three times as powerful as that of the electric lamp. This able scientist points out that when in full power it illuminates a larger surface than the same sized flame of other artificial sources. Moreover, when the cost and trouble of fixing the apparatus for this light are compared with that of the electric or of the oxyhydrogen, it seems highly probable that this form of artificial light will be more extensively used than it is at present.

The want of a reliable, cheap, and uncumbersome artificial light has long been felt by photographers; hence I am emboldened to draw attention to this source, and explain shortly the apparatus required for its use, and refer to a few of the experiments which have been made with it, hoping thereby to encourage its more genial trial in the art of photography.

An ingenious apparatus for the mixing and burning of the nitrous oxide and carbon disulphide vapor has been invented by Delachanal and Mermet, of Paris, by which a constant light can be obtained, and the danger of an explosion obviated, for it must be borne in mind that carbon disulphide vapor is very explosive under certain conditions.

The apparatus consists of a double-necked flask of about 500 c. c. contents, which is filled with pieces of sponge or pumice, saturated with the vapor of carbon disulphide. Into one mouth, A, a bent tube is fixed, through which the nitrous oxide gas passes into the flask. A second bent tube is fixed into the other mouth of the flask; this passes into a wider tube of metal, B, 20 cm. long, which is tightly filled with iron filings, the object of this being to prevent the flame passing back into the explosive vapor contained in the flask.

After passing through this tube, B, the mixture of nitrous oxide and carbon disulphide is led by means of an India-rubber tube to a modified Bunsen's burner. This burner has neither the usual opening for the admission of air nor the arrangement for regulating the quantity of gas passing through it. The nitrous oxide enters the flask through A, and after mixing with the vapor of the carbon disulphide in the flask, passes through B to the burner, where it can be ignited with safety, and with the production of a very blue flame. The size of this flame depends upon the dimensions of the apparatus. The amount of the mixed gases to be burnt can be regulated by a stopcock placed between the tube, B, and the Bunsen burner.

E. Sell, of Berlin, produced, a few years since, some excellent photographs with this light, which were exposed a shorter time than when using the electric or magnesium light, and were in every way more perfect. Riche and Bardy, of Paris, also made extensive experiments with this light, and proved it to be twice as powerful as the lime light. They further showed that the photo-chemical power of the light was due to the blue flame of the sulphur in the combination. Oxygen may be used instead of nitrous oxide gas, but the latter is recommended as being safer.

Photographers interested in the use of artificial light for their science will meet with most valuable hints on the various sources of light in Dr. Stein's new work on light, vol. i., referred to above; but I do not think they will find any more worthy of trial, or easier of manipulation, than the nitrous-oxide carbon-disulphide mixture.—*Photo. News.*

* Das Licht, von S. T. Stein.

A NEW DEPARTURE IN THE METALLURGY OF IRON.

THE first iron manufactured referred to in the oldest of all books, and the only iron or steel known down to the year 1600, was wrought iron made by a primitive process analogous to that of the Catalan forge. Cast iron was obtained by mere accident in the 15th century, the man who made it being under the impression that he could hasten the process of making wrought iron, and he was not more astonished at the result he obtained than ever was a hen on seeing a duckling emerge from an egg. For a long time people did not know what to do with the cast iron thus accidentally obtained, because this special compound of iron and carbon requires much manipulation and many appliances to bring it into any desired form, and for nearly 100 years all that could be made out of it was castings. In the year 1784, however, Peter Onions found out that, by the process of puddling or boiling, wrought or finished iron could be produced from pig iron. In 1855 Bessemer made steel out of cast iron, burning out the carbon by means of cold air forced through the molten mass, and in 1856 Siemens made steel by diluting the carbon of a bath of molten cast metal with the addition of wrought iron or iron ore.

Previous to the Bessemer process of steel making, the only commercial method for producing steel was that of Huntsman in 1740, from pure wrought iron, which was first cemented, and turned into blister steel, and then into cast or crucible steel, which made and still makes the best tool steel; but unfortunately it has the great disadvantage of being very expensive. Although the Bessemer process was a great advance on all previous methods of making steel, both as to the quantity made and the price of production, this method of making steel, although it has achieved a vast commercial success, constitutes an inversion of the natural order of its rational manufacture, inasmuch as in ordinary blast furnace practice the iron ore is first deoxidized and made into a plastic mass, and, if it were possible to stop the operation of the furnace at the stage and hammer the plastic mass to consolidate the iron and get rid of the slag, the mass would not only be wrought iron, but of much better quality than that made by the process of puddling; whereas the process is carried further and the iron is completely molten, simply to be brought back again to the plastic state by the operation of puddling. Moreover, looking at the matter in a rational manner, steel ought never to assume the condition of cast iron; but the operation ought to be stopped when the proper degree of carburization is attained, instead of having to undergo an operation which not only requires expensive plant and machinery, but also involves a serious loss of metal—10 to 15 per cent.—while at the same time, after the operation is finished, the steel is never so good as it would have been if made progressively. Siemens-Martin steel is generally regarded as superior to Bessemer for most purposes, especially ship and boiler plates, but it costs more and cannot be made so quickly, nor in such large quantities. There is reason to believe from certain statements made during the excursions held in connection with the Iron and Steel Institute meeting at Glasgow, that before long not only will wrought iron be made of superior quality and in large quantities by a direct and economical process, but also that steel will be made in an equally direct manner without having to pass through the intermediate range of cast iron, and that in large quantities and of quality equal to that by the Siemens-Martin process, and at about half the cost. Moreover, it is said that there is reason to believe that by a different method of producing cast iron and slightly altering the condition of the blast furnace, pig iron will be made with less than 18 cwt. of soft coal to the ton of pig metal produced. This new departure in the metallurgy of iron must not be regarded as quite too Utopian, when it is considered that the theoretical amount of carbon necessary to make a ton of pig metal is considerably under 8 cwt. All that is necessary to accomplish the

above results is to economically perform all the necessary operations in the blast furnace itself, thereby getting the maximum effect from the coal where that is required.

During the late meeting of the Iron and Steel Institute at Glasgow, we had the opportunity of seeing specimens of wrought iron which appeared as good as any wrought iron ever produced, if not indeed superior; also steel samples which give every promise of satisfying the most crucial tests, and also samples of cast iron, all of which were stated to have been made by the processes of which we have given an outline. Without vouching for the statements made, we see no reason to doubt their accuracy, whether we regard them from a scientific, a practical, or a commercial point of view. A good deal of the above information we must certainly admit is merely prediction, the processes not yet having been carried out on the scale of actual working, but the simplicity and rational sequence of the processes recommend themselves to the judgment, being backed up by the testimony of practical iron-masters, who stated that the conditions mentioned actually did exist in the usual blast furnace practice. The only doubt expressed was as to the possibility of stopping the operation at the critical point; but all admitted that if this could be accomplished, there was a vast future in store for the new method. We shall look forward with much interest to the further development of this new departure, which we are assured is on the point of being made on a commercial scale in at least two of the three kingdoms simultaneously.—P., *The Engineer*.

TWO GAMES.

The Game of Ring and Disks.—In a curved board resting upon a tripod are six small circular apertures

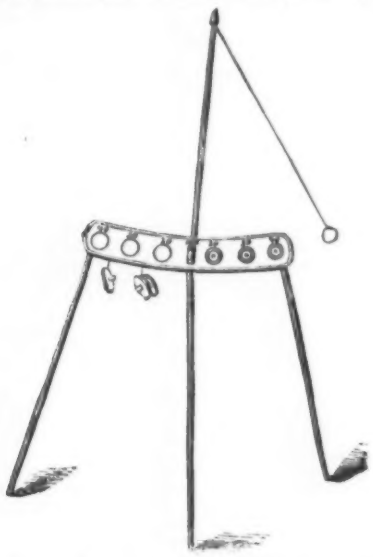


FIG. 1.—GAME OF RING AND DISKS.

into which are fitted small disks, that form so many targets. In the center of the frame there is a rod 34 inches in length, provided at its upper extremity with a cord to which a ring is attached. The apparatus, all mounted, is about two yards in height. The game may be played by three or four persons. It consists in standing in front of the apparatus, at a distance of

FIG. 2.—GAME OF RING AND HOOKS.

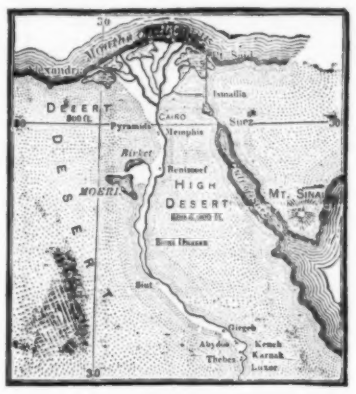
two or three paces, and endeavoring to throw the ring in such a way as to dislodge one of the disks that the player has previously designated. If the disk is removed, as many points are counted as are numbered above the aperture. If the disk is struck, but not removed, only half the points marked are counted. If the player strikes another target than the one he has designated, he loses as many points as are marked over the target struck. The play may be conducted in such a way that each player shall have seven chances.

The Game of the Ring and Hooks.—Upon a tripod stands a rod about ten feet in height, which is provided with an arm from which depends a cord and ring. Upon the frame are arranged three targets, each of which is provided with a hook. Any number of persons can take part in the play. The player stands at about a yard from the apparatus, and throws the ring in such a way that on its return it shall catch on to one of the hooks. How many times each person may renew the experiment is agreed upon beforehand. The throws that have been successful are noted, and after this each of the external hooks counts one, while the central one counts two points. The one who gains most points wins the game.—*Science et Nature*.

IMPOUNDING THE NILE FLOODS.

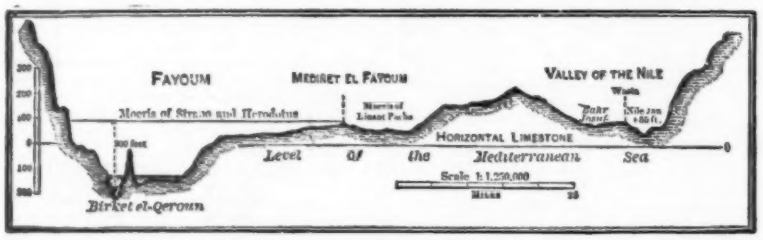
UNTIL very recently, respect for the ancients has not been a characteristic of our times. In their admiration for the achievements of themselves and their fathers, men grew to despise the philosophy of previous ages. They saw that during several centuries, when the mental food of the learned was confined to the classics, the intellectual stature of the race had not increased, and rashly concluded that no real nutriment was to be obtained in this way. The literature of Greece and Rome had great charms, it was admitted, and its study imparted a certain intellectual facility which was supposed to distinguish the "gentle" from the "simple," but for the practical purposes of life it was barren. The truths which it possessed were so overlaid by fable as to be scarcely recognizable, and were so small in quantity as to be not worth the seeking. Those who held these ideas were naturally not sorry when they saw an opportunity of proving their case by pointing to actual errors in matters of fact, and their incomplete knowledge proved a most dangerous weapon against the early chroniclers, who were proved to have been guilty of endless misstatements, either of design or from the duplicity of those from whom they derived their information. Herodotus, Strabo, Homer, and many other writers were classed as the authors of "travelers' tales," upon which no reliance could be placed, and even Cæsar's matter of fact histories did not escape criticism in some of their details. But the ancients could afford to trust to time for their justification, and of late they have had their revenge. The excavations on the site of Troy, the explorations of Speke and Grant, the journey of Dr. Schweinfurth to the country of the pygmies, and many other recent researches, have tended to establish the authority of the old historians, and to show that they were remarkably accurate for an age in which communication was so difficult, and when it was the custom to clothe the accounts of natural phenomena in a poetic guise. Among the circumstantial narratives which were for a long time discredited was the description of Lake Moeris written by Herodotus and repeated by Diodorus, Strabo, Mutianus, and Pliny. According to this famous author, there existed in his time a vast inland fresh water sea about sixty miles south of the pyramids of Gizeh. It was not a natural formation, but was a splendid piece of engineering work carried out at a vast expenditure of money, and requiring a great length of time for its completion. The circumference of it was 450 miles, and its banks were the scene of a stirring activity, recalling the sea shore of the Mediterranean. In its waters a whole fleet of vessels pursued the capture of the twenty-two varieties of fish which it contained, while the royal prerogative of the right of piscary at the great weir was estimated at 50,000*l.* annually. Beside this weir there rose a broad plateau, the scene of an abundant vegetation. Upon the terraces, vines and olives, the symbols of Oriental plenty, produced splendid harvests, while the intermediate stretches of pasturage afforded at once a retreat and a support for the flocks and herds of the State during the inundation of the Nile Valley, and obviated the necessity of providing hay and other dried food for their sustenance. But valuable as was the lake to the Government, and to those who pursued their calling on its margin, or gained their living on its bosom, it would never have come into existence had there not been greater interests to serve than these. Its waters did not rise from the arid sands of the desert nor fall from the fervid sky, which they reflected. They were purely exotic, the product of the winter storms on the mountains of Abyssinia, from whence they had traveled hundreds of miles along the course of the Nile to be caught, almost within sight of their goal—the sea—and imprisoned in a natural depression or erosion of the desert, until the needs of the agriculturist or the burning sun effected their release. The connection between the Nile and the lake was by a canal of great antiquity, which, receiving a part of the river waters, particularly at flood time, led them through a low pass in the range of hills which bound the Nile Valley to the west and conducted them to the lake. In the years when the annual flood showed signs of rising to a dangerous height, the canal formed a by-pass which afforded escape to a vast volume of water, while on the contrary, in the years of low Nile, the current was reversed and the insufficient supply was increased by the surplus of more abundant seasons. At all times the water of the canal was available for the irrigation of the district through which it passed.

Such was the circumstantial report of Herodotus, who states that he actually saw the lake, and gives many details which lend an air of truth to his narrative. For a thousand years of contemporary Græco-Roman history, the account was received with credence, but at the end of the last century it was assailed by Voltaire, and universally rejected as incredible, just as the account of the pyramids would have been, had not their existence offered impregnable evidence in their behalf. The Lake of Moeris, however, was not on the spot to prove its own identity, and its case was further weakened by the presence of the small Lake of Birket el Qerun, which is connected to the Nile Valley by a double canal. Jomard and Wilkinson, assuming the present lake to be that described by Herodotus, attacked his figures, showing to their satisfaction that the depth, circumference, direction, and level given by him were all wrong. In 1842 an engineer, M. Linant de Bellefonds, the Director-General of Public Works, took the matter up. He saw the immense advantage which would accrue to the Nile Valley if a vast natural receptacle capable of equalizing the annual floods could be provided, and he started in search of the remains of the work described by Herodotus. He ran a line of levels westward from El Lahun through the Fayoum, and found certain ancient remains, which he pronounced to be anterior to Herodotus. Among these was a dike to the east and south of Medinet el Fayoum, which M. Bellefonds assumed to be one of



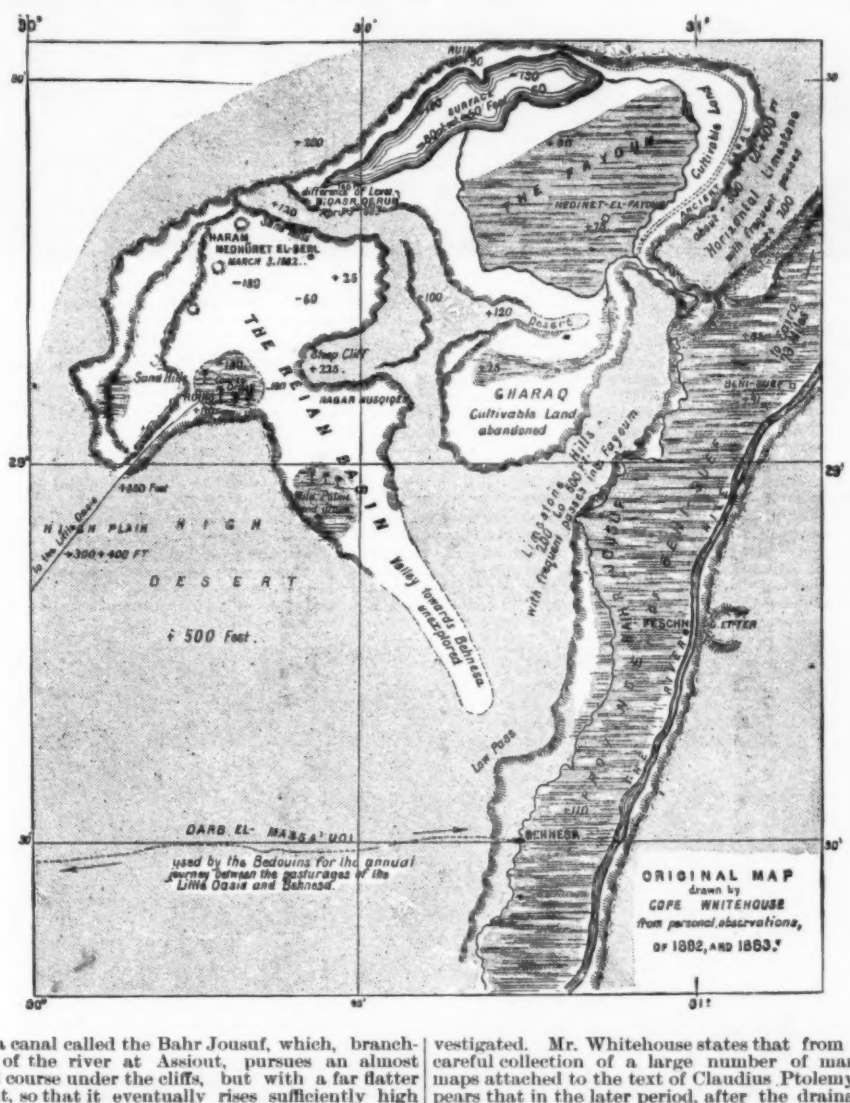
the boundaries of a reservoir, which he calculated to be 75 kilometers in circumference, with an area of 63 square miles, the depth being six feet at the maximum, while the waters were nearly dried up by the time of the annual inundation. Here was a poor substitute for the brilliant picture drawn by Herodotus of a far reaching inland sea of azure color, surrounded by life and bustle, the scene of a great export trade in salted fish. But mean as was the Moeris of the present compared with that of the past, it was accepted as being the same, the difference being ascribed to the exaggeration of the ancient author. The truth that faith and imagination are as necessary qualities in the man of science as in the poet or the preacher had not yet been announced, and the matter of fact school of Egyptian explorers considered this question settled, even finding a confirmation of their view of the subject in an ancient papyrus.

From 1843 to 1879 the question slumbered. Although so near to Cairo, the desert around Birket el Qerun is not a particularly pleasant spot for the amateur explorer, who runs considerable risk of being plundered, and even of having his throat cut, and thus for nearly forty years M. Bellefonds was believed, and the Lake of Moeris, instead of ranking as one of the wonders of the world, shrank in the estimation of those who make a study of Egyptian matters to a comparatively insignificant pool. But at the latter date a new explorer entered the field, Mr. Cope Whitehouse, an American gentlemen and an ardent Egyptologist. Mr. Whitehouse is no follower of the Voltairan school of philosophy; instead of approaching the subject in a destructive spirit, bent on pulling down established beliefs, and proving that all former teachers and historians were leagued to bind the minds of posterity in a chain of deception, he came infused with an ardent enthusiasm, and full of the conviction that great minds of all ages are the subjects of a high inspiration, which fills them with a noble regard for the truth; and that if only the clew can be discovered to the form in which their utterances are clothed, they will be found to be correct. He took up the question of Lake Moeris, and has devoted several years to its elucidation. Once it is admitted that the account of Herodotus is not mere romancing, there is enough in it to set the blood of an explorer on fire, for it not only contains a general description of the lake, but it gives an estimate of its importance in relation to other great works which have been the wonder and admiration of every generation for thousands of years. Near the lake there were other monuments of skill, particularly the Labyrinth, and in an estimate of the engineering works of the world, Herodotus says: "It seemed good to the twelve joint sovereigns to leave a common monument. In pursuance of this resolution they made the Labyrinth which lies a little above Lake Moeris. I visited this place, and found it to surpass description; for if all the walls and other great works of the Greeks could be put together in one, they would not equal, either for labor or expense, this Labyrinth, and yet the Temple of Ephesus is a building worthy of note, and so is the Temple of Larnos. The pyramids are also greater than they are reported, and are severally equal to a number of the greatest works of the Greeks, but the Labyrinth surpasses the pyramids. . . . Wonderful as is the Labyrinth, the work called the Lake of Moeris, which



is close to the Labyrinth, is yet more astonishing." In another place he applies to this erection the word *portentotissimum*, an epithet which carries a force not to be obtained by its English equivalent. No wonder that Mr. Whitehouse, with his abstract belief in the veracity of the ancients, was impelled to go and search for the original of the description. The field of discovery is becoming so trampled that most men have to be content with investigating a single square inch in search of an unknown weed or an unnamed insect, but here was a whole section which had only been pressed by two or three careless feet, and which lay ready to hand. Mr. Whitehouse went, and his first journey has been followed by others which have confirmed his early results and obtained for them universal scientific recognition. Whether he has discovered the Labyrinth, the palace of three thousand chambers, it does not concern us just now to inquire, but it is certain that he found a hollow or erosion in the desert which accurately corresponds to that portrayed by the ancient chronicler, and which could, if it were desirable, be restored to its former size and importance.

The position and value of Lake Moeris will be better understood by a reference to the annexed illustrations, of which the first is a small scale plan of Egypt, the second a section showing the relative heights of the lake and of the Nile, while the third is a map engraved from a sketch drawn for us by Mr. Whitehouse from the records of his own observations and surveys. The first map shows the position and extent of the ancient lake, and also the existing Birket el Qerun. It will be seen that Moeris lies to the west of the Nile, and some seventy-five miles southwest of Cairo. The Birket is



fed by a canal called the Bahr Jousuf, which, branching out of the river at Assiout, pursues an almost parallel course under the cliffs, but with a far flatter gradient, so that it eventually rises sufficiently high (relatively to the river) to follow the course of a pass through the hills, and enter the country on the other side of the range. This part is known as the Fayoum, and included a large amount of land of very valuable character. In the large scale map the character of the country is distinctly shown, cultivated land being indicated with lines, desert shaded with dots, while the clear part is either cultivable land or rocky ground The course of the canal can be easily followed. After emerging from the pass it divides into three; one part goes north through the town of Medinet el Fayoum, and then turns west until it reaches the Birket; another goes south with a rapid fall, and, after creating a tongue of elevated land stretching into the desert, is lost in the sand; the third and principal arm runs west and northwest, and forms the chief affluent of the present lake, delivering to it the waste water of the Nile in too great abundance, for as the evaporation does not equal the yearly influx, the lake has gradually risen and overflowed many thousands of acres of good land. A fourth channel, long disused, but probably the original one, is still to be traced in the sand northward from the western outlet of the pass. It originally watered the land on its margin, and thus conducted its contents around a high and flat peninsula into the Wadi Moieh and Reian, the ancient Moeris.

Mr. Whitehouse set about his exploration in a somewhat novel fashion. Instead of pursuing the usual course of trusting to fortune or to his observation to guide him, he settled in London, before he started, the exact latitude and longitude of the spot he sought, by reference to the ancient authorities, and he went straight to it, just like an early Puritan pursuing the course revealed to him by the Scriptures. On the 3d of March, 1882, he bivouacked in the ruined Temple of Ammon, the Qasr Qerun, between the Birket el Qerun and the Reian Basin, the center of the Moeris-Fayoum district, according to his calculations. He had an additional clew in the fact that an island with pyramidal summits once stood in the middle of Lake Moeris at its deepest part. The pyramids served to show the depth of the water. Their summits rose 300 ft. above the surface, while their base lay 200 ft. below the level of the Mediterranean, and in nearly fifty fathoms of water. They outreached, according to the account, all the other pyramids of Egypt, and were as far above the bed of the lake as the present apex of Cheops is above the valley of the Nile. Now, just to the south of the ridge below Qasr Qerun is a hill marked in the present century maps as a "Grande Butte," and called by the Egyptians Haram, which means pyramid. This Haram, it was assumed, might prove to be the island. A line of levels was run across the Fayoum, Medinet being assumed to be +75 ft. above the sea level, and the bottom of the valley was proved to be —175 ft., or 250 ft. below Medinet. If to this be added the difference in level below Medinet and the top of the Nile flood, it is found that the depression fairly corresponds with the "nearly fifty fathoms" of Herodotus. Again, in 1883, another line of levels was run, with the assistance of an Italian engineer, from the northeast corner of the Qasr Qerun to the surface of the lake, and additional evidence of the accuracy of the former survey was obtained. Thus the southern portion of the basin was proved to correspond to the account given of it; the remainder has not, we believe, been systematically investigated. Mr. Whitehouse states that from a very careful collection of a large number of manuscript maps attached to the text of Claudius Ptolemy, it appears that in the later period, after the drainage and irrigation canals of lower Egypt were in working order, and the cultivation of the land had been extended to the very edge of the Mediterranean and Mareotis, Bourlos and Menzaleh, with diminished area, had been converted into fresh water lakes, and the Great Reservoir had been reduced to the southern basin now known as Wadi Reian. Last winter a collateral investigation was made by Dr. Schweinfurth, who spent twenty-two days to the south of the pyramids and the north of Birket el Qerun, examining the conchology and the general configuration of the country. He found there fresh water shells on the old beaches, of the same kind as he had previously obtained from the top of the island in the lake. He did not, however, get into the Wadi Reian, owing to the opposition of the Arabs, who represented it as a work of danger.

Reviewing the entire evidence, it appears that the account of Herodotus has been amply justified. There has been found a valley forty miles long, twenty miles wide, and more than 200 ft. deep, in connection with two others, one of which, the Birket, is at present small, but which would be much greater if filled to the level of high Nile, while the third, which is not attempted to be shown on the map, is at present unmeasured. Further, the remains of the channel by which this lake was supplied are still to be seen in places. When all these valleys, which were in a sense artificial, were filled with fresh water, and were surrounded with the luxuriant vegetation which springs in Egypt wherever there is moisture, it is no wonder that they should create a feeling of wonder, even in the mind of a man who had seen all the marvels of his times. How the reservoir was made we do not know precisely, but there is a presumption that existing hollows were enlarged by the eroding action of the Nile floods, skillfully controlled, and aided in places by actual excavation.

To the engineer, whether he be an archæologist or not, and as a rule he is not, the account of great works must always be interesting, and this interest is no wise lessened if they have been constructed thousands of years ago in the dim dawn of history. It is a gratification to him to find that civilization and prosperity in the Old World were as dependent upon his art as they are to-day, and that, next to the lawgiver, the engineer, who within living memory was scarcely counted among the members of learned professions, has been the mainspring of the successive civilizations which have arisen in different parts. If we accept Arabic and Hebrew tradition, Lake Moeris is identified with the Pithom of Exodus i. 11, while the Land of Goshen, where Joseph, the all-powerful prime minister, settled his relations, was the Fayoum, or that part of the Nile Valley immediately opposite to it. Thus before Moses, the accepted type of orderly government, we find that immense schemes of civil engineering were carried out.

But the conditions of the Nile Valley are not greatly changed since the Pharaohs. As then, it is the most fertile region of the earth if duly watered. But Nature is by no means careful to supply the flood in measured quantities; one year it is short, and the higher lands become like the surrounding desert; another year it is too plenteous, and works fearful havoc, besides filling the lagoons of the Delta, and permanently submerging thousands of acres. If this irregularity could be abolished, and in place of it a certain height of overflow, a maximum Nile, could be fixed, an immense annual saving would be effected, for not only would the present losses be prevented, but the precautionary measures which have to be taken each year would be no longer necessary, and the annual work imposed upon the *corvee* would be reduced by millions of cubic meters. With this end in view, Mr. Whitehouse is impressing upon the British and Egyptian governments the great importance of his discovery. He does not propose to re-establish the lake in its ancient extent; to do so would be to lay under water a great part of the cultivated land of the Fayoum, but he would fill he Reian Basin, and thus construct an impounding reservoir of magnificent size, which would form an immense outlet for the flood waters of the Nile.

There are three methods of filling this basin. The old channel shown in dotted lines to the northeast of the Fayoum could be reconstructed, and the water led by its ancient course. Or a short canal could be cut through the sand from the Charaq to the Reian; or lastly, a conduit some ten miles long might be constructed from Behnesq to the Reian, thus forming a direct connection with the river. At the same time the flow to the Birket would be stopped, and the land lost by its extension would be regained. Thus the state of things portrayed on the Ptolemaic maps would be reproduced, a large piece of land in the Fayoum would be laid under irrigation, and the sites of many ancient towns rendered again habitable; the Nile Valley would be redeemed from floods, and the work of clearing the channels would be lessened, while, most important of all, the draining and reclaiming of Lake Mareotis, and the other lakes in the Delta, would be rendered feasible, a work which would enormously increase the cultivable area, and would replace what is now alternately lagoon and brackish mud with plantations and cornfields. It is here that the reward for the expense of opening the channel must be found if it is to be undertaken by private agency, and there is no hope of the Egyptian government doing it. The improvement of the Fayoum, although important, is a small matter, while the general security of the Nile Valley cannot be readily turned into money. But the redemption of the lagoons offers a rich reward, which becomes immediately available as soon as effected, and is an enterprise which would draw forth plenty of European capital if its feasibility were once demonstrated.

Mr. Whitehouse has also political views in urging the reconstruction of the lake, but our space will only permit of our touching lightly upon them. Ancient Egypt was always a battle ground, and was held by many masters, each being in turn the ruler of the world while it retained possession. Even in later times the Arab domination threatened at one time the security of the whole of Europe, while Napoleon showed, by the risks he ran on the Nile, the value he attached to the land of the Pharaohs. At the present moment Egypt lies in the hand of England, and it only needs that hand to close to effect the solution of the Eastern question. If we took formal possession, the refilling of Lake Moeris would create for us an almost impregnable fortress, a Gibraltar in the desert, from which it would take the military might of Europe to dislodge us. It would contain an irregular triangle of land, bounded on one side by the Nile, on another by the Birket el Qerun, and on the third by the Reian Basin, and capable by its fertility of maintaining an immense army for a unlimited length of time. This triangle could only be entered by passes in a few places, and these could be rendered impractible by the erection of forts, so that if lower Egypt were overrun by an enemy, the capital would be always within striking distance of the garrison in the Fayoum, and the subjugation of the country would take long, even supposing we were quite unable to maintain operations on the seaboard. We merely put this forward as one of the collateral advantages of the scheme, although, as we are pledged to stay in Egypt for many years, it is one that is worth consideration. But the main value of Mr. Whitehouse's discovery is the possibility which it unfolds of correcting and regulating the Nile floods, and as a consequence of this, of recovering the land overflowed by the lagoons. This is an enormous area, as will be seen from our small map, and forms a very considerable proportion of the country. People are apt to forget, in view of the wealth of Egypt, how small it is. Omitting the Delta, it almost realizes the definition of length without breadth, and much of the Delta is being wasted by the infiltration of salt from the marshes killing the vegetation. This could easily be stopped and the salt washed out of the land by fresh water and rice crops, according to a well known process, if the engineers had only the lagoons to cope with. But every few years comes an extraordinary Nile flood, and then the whole work has to be done

over again. If these floods could be trapped a hundred miles above Cairo, and impounded in Lake Moeris, the question would be solved, and Mr. Whitehouse's zeal for the reputation of Herodotus would have wrought more good to the country than it has derived from the entire European Concert.—*Engineering.*

A VISIT TO THE VESUVIUS OBSERVATORY.

By P. Marcillac.*

"Everybody knows the Vesuvius Observatory by name," said Mr. Faye recently in a note addressed to the Academy of Sciences. There is, in fact, no electrician who has not heard it spoken of; still, as there are few who know it *by sight*, I think, before passing in review the apparatus used there, that I ought to give some details as to the exact position and internal arrangement of this celebrated station.

As shown in Fig 2, where the location of the station is indicated, Vesuvius rises straight from the sea, and reaches a height of about 4,300 feet above the level thereof. Taken isolatedly, the bulk of the volcano appears to be greater than that of certain well-known summits which are higher, but which are partially lost in rocky masses of the first rank. Up to about midway between base and apex, reddish or black ridges of lava, radiating from a center like the spokes of a wheel, alternate with long strips of earth that are planted with the celebrated vines that yield *Lacrymæ-Christi*. At about 700 yards begins the base of the great upper cone, which keeps increasing every day from the material thrown out by the crater. To the east spreads out in a circle Mount Somma, whose cone is active in the center. This was formerly the culminating point of Vesuvius, but is now exceeded in height by the cone of ashes. At this altitude, and looking toward Naples, stands the Observatory upon the summit of a prominence at whose base lie to the right and left two long lines of hardened lava that possess the form of enormous cables twisted into an inextricable mass.

A meteorologist might seek in vain for a finer view and a situation at once so perilous, so charming, and so strange. Apropos of this, two facts taken at random: at the time of the great eruption of 1872, the temperature reached 72° C. outside of the Observatory, which was hemmed in by two sheets of fire several miles in length; on another hand, some time before my trip in the month of May last, a terrible squall of wind removed every trace whatever of the irons that held and strengthened the shaft of the anemometer, and buried the whole in ashes, so that it was impossible, the guardian told me, to again find the place where the thing had occurred. Under conditions such as these it is easy to observe phenomena that tend toward a maximum of energy, and that are consequently more clearly marked. The Observatory, as a whole (Fig. 1), constitutes a vast pavilion, whose different stories contain, along with special apparatus, rich collections of minerals. A beautiful flight of steps fronting an elegant little garden gives access to the first room, which is provided with glass cases containing a unique collection of ashes from the different eruptions of Vesuvius. These pulverulent debris, whose nature seems to exclude them from any other study than that of geology, are directly and immediately connected with the electric experiments. As well known, in fact, in the collectors now in use, we employ a gas, a flame, or a liquid for collecting the traces of atmospheric electricity. Mr. Palmieri, the director of the Vesuvius Observatory, conceived the idea of using volcanic ashes for an analogous purpose. Some of this material is of the coarseness of fine starch, and some again is as fine as the ashes of a cigar. These ashes are used by Mr. Palmieri instead of a liquid for collecting atmospheric electricity according to processes that have been detailed by him in a recent memoir. Continuing our examination of the station, we find, alongside of small geological wonders, and geodes as large as a bomb-shell, an apparatus for observing the variations in terrestrial magnetism. As this instrument is not special to this station, and is moreover well known, I shall not stop to describe it, but shall merely say that it is an apparatus of Lamont of Munich. As well known, it consists of a collection of needles formed of small strips of steel properly suspended, the slightest movements of which can be observed without trouble, owing to a system of reflection identical with that which Sir William Thomson uses in his galvanometers. There is nevertheless one remark to be made on the subject of this apparatus and the *role* that it plays on Vesuvius, or is capable of playing in any other place of observation of similar location; Mr. Palmieri considers it as a valuable aid in observing *temporary, local* variations in terrestrial magnetism, but he rightly objects that the measurements furnished by it, as regards *general variations* in the different elements of the magnetism of the globe, have no signification at the Vesuvius station. In fact, says he, the peculiar magnetism of the rocks or lavas, which possess characteristic polarities, changes these values of general magnetism from one place to another, and sometimes even at the same point, if some rock or mass of lava of larger size be near. So the results obtained are considered by Mr. Palmieri only as *local* indications that vary with *local* causes. As for *general* variations, it is not on Vesuvius, but at some distance therefrom—at Naples—that they are studied, the magnetic secondary effects of the lavas being then considered as unworthy of being taken into consideration. It is useless to give in this place a description of numerous instruments that are

Fig. 1.—THE VESUVIUS OBSERVATORY.

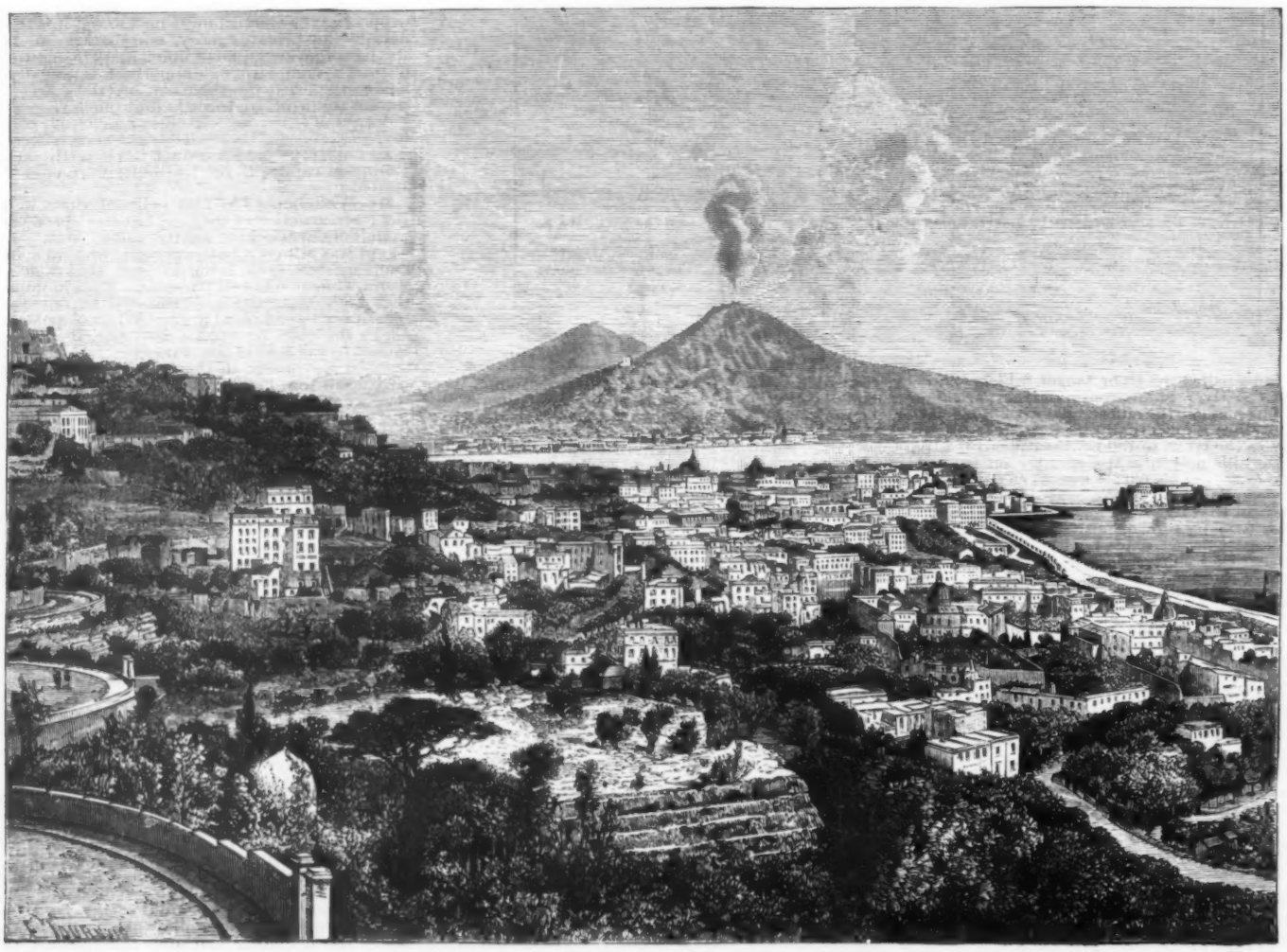


Fig. 2.—GENERAL VIEW OF NAPLES.

* In *La Lumiere Electrique.*

common to all meteorological stations, and I shall therefore confine myself to the statement that the Vesuvius Observatory possesses an ample collection of thermometers, barometers, pluviometers, hygrometers, etc., plus a certain collection of peculiar objects, such as two beautiful reductions in relief of Vesuvius and Etna. These very remarkable pieces, which are of galvanic copper, figured in the Italian Pavilion at the Paris Exposition of Electricity.

The first story of the station is almost wholly set apart for numerous seismographs, or apparatus for registering shocks, which are but little known and not much used except in Italian observatories. Without

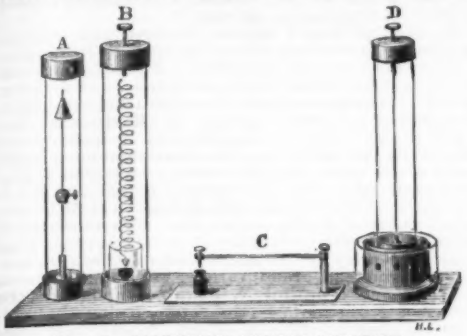


FIG. 3.—VARIOUS SEISMOGRAPHS.

entering into considerations upon the origin or laws of earthquakes, it is difficult to keep from saying a few words concerning these phenomena, *apropos* of seismographs that serve not only for showing their presence, but also for measuring their intensity. The behavior of these movements is exceedingly variable. Sometimes the ground vibrates horizontally like a table that one has come into contact with. Sometimes the terrestrial crust vibrates after the manner of the sides of a boiler, and sometimes the trembling is analogous to that of a vibrating membrane whose surface has been raised or depressed by a smart blow given to it from below or above. From this it will be seen that it is indispensable to have very different styles of the apparatus, which, although designed for the same object—the registration of earth tremors—are adapted through their special arrangement for the observation of different kinds of movements.

Seismographs.—Of these apparatus, some are simple indicators, while others on the contrary comprise an indicator and a registering device. The apparatus are represented in Fig. 3, at which it is only necessary to

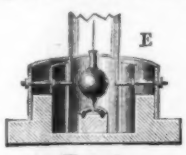


FIG. 4.

glance in order to understand how they work. A is formed of a steel wire fixed by one of its extremities, and provided with a spherical slide, that can be held stationary at any desired point by means of a regulating screw. Its free extremity is provided with a light cone terminating in a needle. The whole is inclosed in a glass cylinder.

At the least lateral oscillation of the earth the affair vibrates or oscillates. It is only necessary to observe the needle's oscillations, the amplitude of which indicates the degree of intensity of the subterranean action. The apparatus, B, comprises a helix of brass wire provided with a metallic ball or a sharp cone, whose platinized point touches the convexity of a small quantity of mercury contained in an iron cup. At every oscillation of the earth the spiral successively elongates and contracts, and renders visible to an attentive eye motions that even the most experienced observer does not perceive at his feet, although standing upon the ground that is vibrating. It is rarely the case that the instrument is at rest. It follows, so to speak, all the pulsations of the volcano, and makes accurately known the variations in its energy. If a current be passed into the spiral, and the iron cup be connected with a registering device that we shall describe further along, we can evidently effect a registration of all the movements of the ground. At C is seen an apparatus for the registration of exceptional-

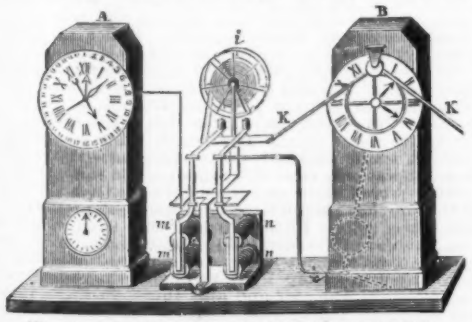


FIG. 5.—REGISTERING SEISMOGRAPHS.

ly strong shocks. A small strip of steel is here held horizontally by means of a vertical column, and its free extremity is provided with a platinized point separated by a fraction of an inch from a cup full of mercury. D represents a seismograph for indicating horizontal motions. In the interior of a glass cylinder is suspended a very fine wire that supports a small brass ball, which is provided beneath with a platinum point. Under this latter there is an iron cup whose bottom presents the form of a truncated cone. The annular cavity thus obtained is filled with mercury, which forms a ring into which the platinum point descends when a shock moves the pendulum from its vertical position. This contact closes an electric circuit, and a signal is registered. The instrument is further provided with a series of small glass tubes arranged like the spokes of a wheel, and very movable. The brass ball strikes one or more of these tubes in its lateral motions, and thus allows the direction of the undulation to be seen. This part of the instrument is shown in Fig. 4.

These various earthquake recorders being now known to us, let us see how the shocks are registered at the Vesuvius Observatory.

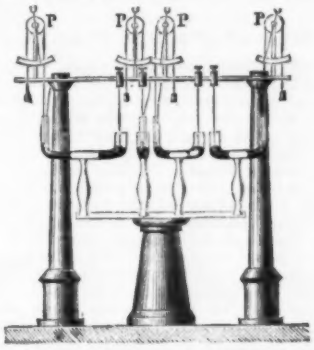


FIG. 6.—APPARATUS FOR REGISTERING UNDULATORY MOVEMENTS.

Fig. 5 gives a view of the *stationary* registering seismograph, so called in contradistinction to another style called a *portable* one, designed for temporary use only in cases where peculiar phenomena are manifested that require but a transient observation, and where there is no meteorological station.

The stationary registering apparatus consists of two clocks, A and B, the former of which indicates the hours, minutes, and half-seconds, while the latter is at rest, and does not start till the occurrence of a shock, as we shall see further along. When this clock is running, it causes a band of paper, *k k*, on the wheel, *i*, to unwind at the rate of twelve inches per hour. Between the two clocks there are two electro-magnets, *m m*, *n n*, whose armatures are connected with two bent levers, one of which carries a black pencil and the other a red one. These levers are so jointed that when the armatures are attached, the pencils press against the paper band which is passing under their points. If a very

FIG. 7.

slight vertical shock occurs, the electric current influences the magnet, and this starts a simple mechanism that stops the clock, A, and the latter sets a bell ringing. The clock, B, then begins to run, and carries along the paper band, upon which the red pencil will trace lines whose length gives the measurement of the shock's duration. This done, a blank space is left upon the unwinding paper; but if, say an hour afterward, another shock occurs, we shall find twelve inches beyond, on this paper, the traces of a shock and its duration, and so on. If, instead of being vertical, the mo-

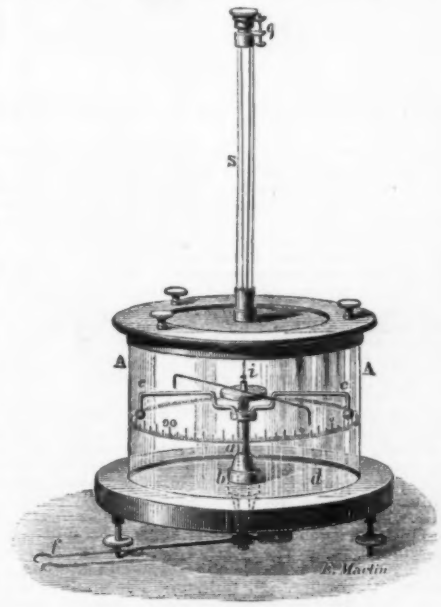


FIG. 8.—ELECTROMETER.

tion is horizontal or undulatory, the current will pass into the electro, *n n*, which will work as just explained, and the black pencil will register the shock and its duration. It is clear, then, that being notified by the bell, the observer will proceed to the apparatus, although, as may be seen, these latter, in case of his absence, will operate in such a way that the phenomena cannot pass unnoticed. From the description of the indicators above given, it will be seen that it suffices to connect with the first electro one of the vertical shock indicators, and with the second an indicator of horizontal shocks. It now remains for me to describe the model which best indicates these latter, and which, likewise, registers undulatory motions. This is shown in Fig. 6.

Here a sort of frame supports four communicating tubes and four uprights provided with channeled pulleys. One of the vertical branches of each tube is wide, while the other is narrower—about one-third the diameter of the former. The four tubes, which contain mercury, are placed in the direction of the cardinal points. Into the wide branch of each of them runs a platinum or iron rod, while in the narrow branches there are platinum points that nearly touch the mercury (Fig. 7). Under such circumstances, if a shock—even a slight one—occurs in the horizontal direction of one of the tubes, the mercury will touch the platinum point, the electric circuit will be closed, the black

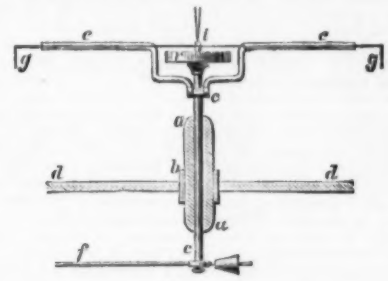


FIG. 9.

pencil electro will operate, and the shock will be registered. In addition, there is in each narrow branch an ivory float suspended by a cocoon fiber which passes into the channel of one of the pulleys, *q, q, q, q*, and which is provided with a counterpoise. According to the motions of the float, the pulley revolves and displaces a needle fixed upon its axis, thus indicating the direction and amplitude of the movement. If an oscillation occurs in a direction intermediate between that of the tubes, two needles will be moved.

A final word upon these apparatus of Mr. Palmieri's, which have served as models for all those that have since been devised: It is not only at Vesuvius that they are employed, for the Society of Seismology of Japan possesses two beautiful models made by Messrs. Negretti & Zambra, a third is in use in Mexico, and a fourth, I believe, is to be found at San Francisco.

Evidently, the mountain masses of France are not overturned or agitated as often as are those of the countries above cited. There is a marked difference

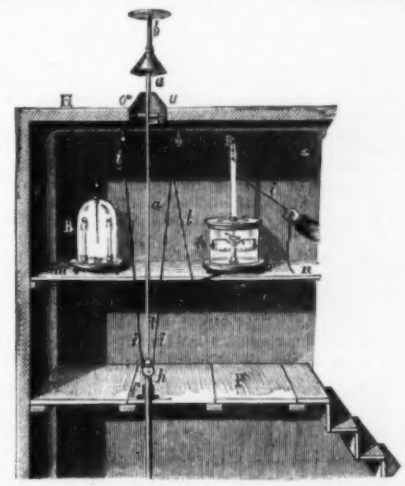


FIG. 10.—APPARATUS FOR ASCERTAINING THE ELECTRICAL STATE OF THE ATMOSPHERE.

between southern Italy, with its three volcanic craters; Japan, with its 29 ignivomous cones; Mexico, with its 23 volcanoes; California, with its single outlet of Las Virgines, and our provinces of Auvergne, Provence, and Dauphiny, that have been dormant for several centuries. But it appears to me that it is to be regretted that our observatories, at least those in the three provinces that I mention, are not provided with seismographs. The effects are feeble, it is true, and certainly less frequent than in volcanic centers, but they are not to be left out of consideration. . . .

The electrical apparatus, properly so called, and the piles that actuate the various registering apparatus, seismographic clocks, anemographs, etc., are placed on the last story of the observatory. Here are arranged, and attended to with particular care, the Callaud elements that compose the batteries of the station. Here

FIG. 11.

also are found the constant piles as modified by Mr. Palmieri, and which the learned physicist makes use of in his open air experiments on the nature of the electricity shown by his portable registering apparatus. Here, finally, figure, in the guise of historic apparatus, the ascending or descending liquid vein collectors, the precursors of those so eminently practical instruments that are now used at all the Italian stations, and that consist of an electrometer, a movable collector, and a modified Bohnenberger electroscope.

Electrometer.—Let A A be a cylindrical glass box, the circumference of which is provided with a scale, and

which is supported by a metallic base, and is covered with a glass disk having quite a large aperature in the center (Fig. 8). In this aperature is fixed a glass cylinder, S, containing two cocoon fibers to which is attached a thin disk of aluminum, *i*, traversed diametrically by a very fine wire. The disk, *i*, revolves in the interior of a gilded metallic cup that carries two horizontal arms, *e e*, formed of tubes cut in the direction of a plane at right angles with that of the cup. The wire moves parallel with these arms, and approaches or recedes from them according as it is or is not electrified. These arms, *e e*, are supported, as is the cup, *r*, by a copper rod, *c*, which is insulated from the lower surface of the apparatus by a sleeve, *b b*, of a substance of peculiar nature (Fig. 8). Leaving aside the applications of the instrument itself, I desire to speak only of the composition of this substance, which is capable of rendering a genuine service to constructors or to electricians in general. It is a current formed of two-thirds Greek pitch and one third calcined plaster by weight. This plaster, called in Italian *scagliola*, is not the natural plaster, but plaster raised to a high temperature in order to divest it of half its water, and which afterward thrown quickly into water hardens in taking up the liquid lost. The cement thus obtained forms when warm a pasty mass that must be continuously stirred with a spatula until it becomes very homogeneous. The substance is then allowed to cool somewhat, and, according to requirements, is poured into moulds or applied while yet viscid to the piece to be insulated. It has not the consistency of ebonite, and it rather resembles Spanish wax; but it is possible, with some precaution, to turn it in a lathe and polish it. It then exhibits the appearance of amber, with a slight shade of bistre. Its insulating power is superior to that of ebonite, and its cost price is next to nothing. Finally, it possesses two properties of the first rank, from an electrical standpoint, and that is that its insulating qualities are not lost through a considerable degree of heat or moisture It is to the perfect insulation obtained with this material that the director of the Observatory attributes the superiority of his excellent electrometer, which, as Mr. Mascart said at the Meteorological Congress at Rome, "might serve for controlling the results furnished by other apparatus of the same nature."

Apparatus with Movable Conductor, (Fig. 10).—A metallic rod provided at its upper extremity with a brass disk, and at its lower with a channeled pulley carefully insulated from it, such is in substance the collector of electricity used at the Vesuvius Observatory. A triangular guide (Fig. 11), provided with springs, serves to hold the rod vertically during its ascent, and to establish a communication between the collecting disk outside of the roof and the bifilar electrometer.

The entire maneuver consists in pulling a cord, *i i i*, which passes through the channel of the lower pulley, *h*, and then through that of a second one fixed to the ceiling of the room. This obliges the rod to rise above the roof, H, and permits of collecting whatever traces of electricity the atmosphere may show. The latter influences the electrometer, and it only remains for the observer to note the deflection obtained.

As may be seen, nothing could be simpler. Although this kind of a collector may at first sight seem to be rudimentary, it will quickly be seen how valuable an aid it is capable of proving in mountain stations. In these, much greater difficulties are encountered in the way of devising gas or water reservoirs for supplying liquid vein collectors than in the vicinity of large cities. On another hand, if it rain, blow, snow or hail, the regularity of the flow is much disturbed, if not absolutely stopped. It must be admitted that there is nothing to be dreaded with the Italian apparatus, the management of which is at once rapid, simple and sure. This, at least, is the impression that I formed of it after being present at a series of experiments at the Vesuvius station.

It is objected that this system does not permit of a continuous registration, and the objection is evidently a serious one. Mr. Palmieri answers this by demonstrating the irregularity of the flow of liquid or gaseous jets exposed to all the caprices of the weather. He dwells, moreover, upon one capital point, to wit, that, even in not taking into account the irregularities and losses that the at-present-known continuous registering apparatus undergo, the curves do not indicate much unless the indications they give are doubled by a personal observation of the meteorologist. In banishing all kinds of continuously registering apparatus from the station that he directs, the learned Italian has desired to command the attention of the operator, and oblige him to consider the motions of his instruments and the aspects of the heavens simultaneously. "Only in this way," says he, "have I been able to succeed in discovering and enunciating the laws that govern atmospheric electricity." This idea has been clearly summarized by Mr. Faye in his recent memoir upon the labors of Mr. Palmieri, and I can only cite his conclusion, which is as follows: "Mr. Palmieri thinks the observer should be alongside of his instrument, in order to note the unforeseen details that would be unable to inscribe themselves automatically upon a sheet of paper. His methods are applicable, moreover, with equal success to the study of ordinary electricity in calm weather, and, in case of a storm, to all the phases of the phenomenon, without causing the observor to run the risk of being struck by lightning."

The instruments that I had an opportunity of studying at the Vesuvius Observatory are just the opposite of certain physical apparatus, being simple, cheap, elegant even, and at the same time strong. The management of them is, as a general thing, so simple that the custodian of the station often makes the electrical tests, and that too with much accuracy. The results obtained with them are well known, and are of great value. It is natural, then, to wish that we may see them introduced into France, and come into extended use here, not to the exclusion of other apparatus (which they would serve, as required, to control or complete), but concurrently with them, at least at mountain stations, which might thus be confided to observers who have but a very limited knowledge. It would be especially interesting to see what results they would furnish elsewhere than at the Vesuvius Observatory. Volcanic action and the friction (of extremely variable intensity) of smoke or gases against the sides of the crater, or through the crust of the mountain, constitute almost an exceptional case for this observatory. When, for example, fissures open and permit the escape of torrents of gas or bluish smoke, which the wind whirls over the blocks of hardened lava, there is necessarily some friction, without speaking of the multiple chemical effects that escape the observer, and that must give rise to electric manifestations of exceptional intensity. The Observatory is not then in a normal siuation. It would consequently be necessary to examine, under *ordinary* circumstances, the results furnished by the ingenious but too little known instruments of the observatory under consideration. The cost, which is a matter never to be left out of consideration in questions of installation, appears to me very moderate and the construction very easy.

HYBRID PITCHER PLANTS.

Although Pitcher plants have long been known to cultivators, it is only comparatively recently that they have been much grown, a circumstance doubtless attributable to the indifferent success which attended the efforts of many who attempted their cultivation. Now, however, when their requirements are better understood, they are gradually finding their way into the collections of those who can appreciate beauty beyond that afforded by brightly colored flowers. With Nepenthes or Pitcher plants, as with everything else of an attractive character, hybridizers have been busy, and their labors have been rewarded by the production of a large number of varieties possessing great merit, and which, while combining as they do more or less of the general character of the species from which they originated, are yet so far distinct from the parent plants in both color and form as to render them most acceptable additions to the family. Apart from varieties resulting from cross-breeding, Nepenthes raised from seed, the produce of plants fertilized with pollen of the same species vary considerably in their marking; in some the spotting is much deeper and more intense than in others. A great difference in this respect may

A NEW HYBRID PITCHER PLANT (NEPENTHES COMPACTA), SHOWING HABIT OF GROWTH.

be seen in such kinds as N. Rafflesiana, the color in the spotting of some forms of which is much more intense than in others. Nepenthes being dioecious, it is difficult to have a plant bearing female flowers open at a time when pollen can be had to fertilize them, and this has doubtless been the cause of comparatively little having been done in the way of getting improved forms of the most desirable species. There is, I think, good reason to suppose that, lurking in the islands of the Indian Archipelago, there are still species bearing much larger pitchers than any that have yet been introduced or described. Henchall, the late Messrs. Rollisson's collector in these regions, showed me at one time dried pitchers much larger than such as are borne by any kind that we yet have in cultivation.

The three hybrid varieties are, as will be seen, quite distinct both in form and marking from kinds which we already possess. In N. Dormaniana the peculiar flask formation is less decided than in many of the species; the pitchers from their widest part at some distance from the bottom almost gradually taper upward, while the deep red of the irregular markings stand out conspicuously, owing to the grounds color being much paler than that of most kinds. There is, too, an absence of deep color on the lid and rim surrounding the orifice. N. Williamsi, the smallest in the group, is a very handsome, highly colored variety, with the red coloring, paler or darker as the case may be, distributed over almost the entire pitcher, and as the pitchers get older the whole surface becomes as deeply colored as a well-grown example of N. sanguinea. N. Henryana has the green ground color deeper, while the marking is much the deepest in the upper portion of the pitcher; it is the largest sized one of the group, with the lower part more dilated than in the others. The wings of all are conspicuous and the teeth prominent. Among other hybrid Nepenthes in Mr. B. S. Williams' nursery, Holloway, may be named N. atro-sanguinea, a variety in which the pitchers are medium sized; their ground color red slightly marked with pale yellowish green. In form they are somewhat cylindrical, the bottom being broadest, and the wings fully developed and fringed. N. coccinea has pitchers similar in size to the last; their ground color is crimson, spotted with yellow; they are flask-shaped above, cylindrical toward the top, and the ribbed rim round the mouth is of a dark blackish red. One of the best features connected with these Pitcher plants, which are of American origin, is their fine and vigorous growth; the shoots are short-jointed, and the plants profusely clothed with leaves that produce pitchers much more profusely than many species; they also appear to retain them in a fresh condition longer than most Pitcher plants. Even in spring, before much active growth has commenced, the plants are as fully furnished with highly colored pitcher as others are in autumn.

Mr. Dominy was, I believe, the first who attained success in hybridizing Pitcher plants. N. Dominiana, a cross between the well-known N. Rafflesiana, still one of the finest known kinds, and a green-leafed species, is a very handsome plant, in general character much resembling its female parent, N. Rafflesiana. The work begun by Mr. Dominy has been successfully continued by Mr. Seden and Mr. Court, and many handsome kinds have been the result. Among these may be mentioned N. Courti, obtained by crossing an unnamed Bornean species with the pollen of N. Dominiana. It is a handsome variety, with flask-shaped pitchers 7 inches or 8 inches long. The ground color is green, densely spotted and shaded with deep crimson. N. Mastersiana, a grand variety, was raised between the rare and beautiful N. sanguinea and one of the forms of N. distillatoria, the former being the seed-bearing parent. It is a robust grower, and bears pitchers about 8 inches long, somewhat distended in the lower part and cylindrical above; the whole surface of the mature pitchers, as well as the lid, is of a deep claret red, relieved by slightly lighter markings. This fine kind is the result of Mr. Court's handiwork. N. Morganiæ, a variety raised in America by Mr. Taplin, who has also been very successful in hybridizing Nepenthes, is a large sized, very distinct kind, with stout, flask-shaped pitchers, remarkable for their breadth in the lower part; the wings are also ample. While young the pitchers are mottled with bright red and light green, but when older they become nearly wholly deep red.

As regards culture, the general opinion that used to be entertained was that Pitcher plants not only required to be kept in all but a saturated condition at the roots, but that they also must have a reeking atmosphere and be heavily shaded. Under such conditions, with a high temperature, the plants with me grew apace—in fact; they grew too fast; but the shoots came long-jointed and weak, with comparatively little disposition to produce pitchers, without which, it is needless to say, they have little that is interesting or attractive about them. The leaves made in the late autumn, winter, and early part of spring never pitchered at all; it was only from those produced in summer that pitchers were formed, and these not more than a fourth of the size they should have been, and with proportionately little color. Little satisfied with such results, I headed some of the plants down and made the shoots into cuttings, which when rooted I placed in quarters where they got more light, through being more elevated toward the roof, and also through using a thinner shading. The first season there was a marked improvement, which induced me to try some of the stock hung up, so that the extremities of the shoots were not more than a foot from the glass; here the growth made a season after was of a very different character, the shoots not being half the length between the joints, with leaves much shorter and of greater substance and pitchers double the size, with the color of those that were not naturally wholly green much deeper. Since then, whenever an opportunity has occurred of saying anything on the cultivation of Nepenthes, I have continually urged the necessity of a completely opposite course being followed to overshading with a confined, reeking atmosphere, as well as the plants being kept too far from the glass, conditions collectively the cause

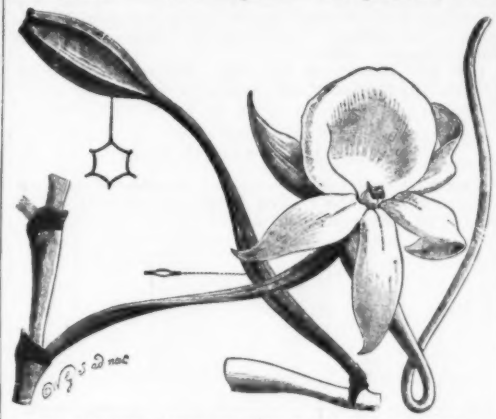
of my failures. At the same time it is well to remind beginners in the cultivation of these plants that the opposite extreme of anything approaching a dry, parched atmosphere, too much air or exposure to the unobstructed rays of the sun, is equally fatal. Neither is it any use looking for a full measure of success unless where plenty of heat can be given them at all times of the year. To do justice to them, they require to be kept moving even through the winter, at which season the temperature by night for nearly all the species should not be much under 70°; for although they can be grown when kept something lower than this, still, under such conditions, many of the leaves will fail to produce pitchers, and those formed will not attain nearly the full size which they are capable of being grown to. The material which I have found them to thrive the best in is the fibrous matter from good orchid peat with every particle of the earthy decomposed matter shaken out. This chopped up, with something near a like portion of sphagnum, to which is added a third part of small crocks or charcoal and a sprinkling of sand, will keep in a condition to suit the roots longer than sphagnum and crocks alone. The house in which I grew them was span-roofed, standing ends north and south. The blinds, composed of thin gauze canvas, were run down in summer, when sunny, a little before nine in the morning, and wound up from half-past four to five in the afternoon. The plants were syringed and watered daily through the season of active growth and every other day in the winter. Leaving out some of the hybrids which I have not grown, all the kinds, excepting N. lanata, an extremely rare species, did best when in a house standing in the position mentioned with no more shade than I have named; this species I found could not bear so much light as the others; consequently it was hung some 18 inches lower. As already stated, the plants were hung up close to the roof midway between the eave and the ridge, to which latter were the ordinary hinged ventilators. If nearer the ridge than this when the ventilators were open, the air would have been too much for them.

When the ventilators were open in sunny weather, the blinds being down, the air was still further prevented from acting unduly on the plants. Each side of the roof being furnished with ventilators, the air was always admitted at the opposite side to that on which the wind blew, otherwise the current would have been injurious. The house is nearly 50 feet long by 20 feet wide, and was occupied by a general collection of stove plants. The night temperature through the winter was kept as near 70° as possible, except during severe frost, when it was some 4° lower; the rise in the day was proportionate to the state of the weather. In warm summer weather, as a matter of course, the night temperature was higher; and all through the growing season with sun heat in the daytime it was much increased, often running up to 90° or 95° with plenty of moisture in the atmosphere, which later in the winter season was never so dry as most general plant stoves are kept.

I have been particular in these details as to the position of the plants in the house, the temperature they were subjected to, admission of air, atmospheric moisture, as well as to the roots, for upon these collectively depend the full measure of success being attained. The fact of Nepenthes requiring to be kept always wet at the roots naturally tends to the potting material in the course of years getting so far decomposed as to become close and pasty. This they cannot bear; consequently, when it gets into anything approaching that condition, it requires replacing. But Nepenthes cannot bear shaking out, like many other plants will, through the extremely fragile nature of their roots, as if this is attempted, the complete destruction of the fibers is all but certain. When the soil happens to require renewing, I have found it best to turn them out of the pots, plunge the ball in a pail of tepid water, and in it, by careful movement of the fingers, gradually get the material from them. Some difference of opinion exists as to whether pots, or baskets made of some open material, answer best for Nepenthes. After trying both, I unhesitatingly give the preference to pots. Baskets may do where a house can be devoted to them, and consequently where the admission of less air is necessary than in a stove with a mixed collection of plants, as under such conditions the roots, as they protrude through the baskets, are not likely to have their growth stopped to such an extent as is unavoidable with the greater admission of air necessary when grown in company with other plants that would not succeed kept so close. But for one instance where a house is devoted to Nepenthes, there are scores where they must either be grown in a general stove or not at all; and if ever they were to come so generally into cultivation as they deserve, their treatment requires to be such as to give the best chances of success when grown along with other things. Beyond this, under pot culture I have had plants more than double the size, with proportionately larger pitchers according to their kinds, than I have ever seen grown in baskets. I have had N. Rafflesiana in a pot with over half a hundred perfect pitchers, the largest of which held over a pint each—*T. Baines, in The Garden.*

AERANTHUS LEONIS.

THIS singular and beautiful orchid may be regarded as one of the most interesting of recent introductions. In habit of growth it is unlike any other orchid, its thick, flat, 4 to 8 inch long, sword-like, sickle-shaped leaves being uncleft, except at the point of juncture with the stems, from which they gracefully curve on each side of the stem. The flowers, which are profusely produced on stout spikes, are white, the dark green leaves forming an effective background; the spur, which ranges from 5 to 7 inches in length, is curved in a most curious manner, as will be seen by reference to our illustration. The lip occupies its original or normal position, for the customary position of the lip on the lower half of the flower is due only to the twisting of the ovary after the first formation of the flower. The seed-vessels, or fruits, too, which vary in form in the different specimens, are interesting in structure. Aeranthus (Angræcum) leonis was discovered and collected by M. Leon Humblot in the Comoro Islands growing at a height of 5,000 feet, and it is therefore said to be an intermediate, if not a cool-house plant—a statement which its whole aspect fully bears out, the leathery texture of the leaves and the wiry nature of its roots seeming to assert that the plant is anything but delicate. It will, no doubt, succeed admirably in the Cattleya-house, either in baskets or pots, in sphagnum moss, if kept tolerably moist when at rest, and copiously watered when growing. None need fear to acquire this lovely stranger, for it is one of those plants which take kindly to a new home, and it will, under cultivation, even surpass in beauty the flowers gathered when the plants were collected. The question arises, What can be the moth which insures the fertilization of such a plant? The proboscis must needs be long and flexible to penetrate the curiously curved nectary of such a plant.—*The Gardeners' Chronicle.*



FLOWERS AND FRUIT OF AERANTHUS LEONIS.

THE FORCING OF LILACS.

FOR a few years past superb bouquets of white lilacs have been exhibited by our florists for our admiration in midwinter. Our tables are ornamented with them on reception days, and they also contribute as an ornament at baptismal and marriage festivals, and are often used as a substitute for bonbons on the first of January. Few persons know where these flowers are cultivated. It is in the suburbs of Paris, the two most important establishments being that of Mr. Moynet at Montrange and that of Mr. Delaunay at Montreuil-sous-bois.

We had an opportunity of visiting Mr. Delaunay's establishment a few days ago, and, thanks to the kindness of its amiable proprietor, we saw all the details and got all the data in regard to the culture. The plants used, which are of the variety called "Marly," have a beautiful violet color that they must lose entirely in the darkness of the greenhouse. They are in the first place planted out in vast nurseries at Vitry, and stay there until they are from six to eight years old. At the end of this time they are carried, along with the ball of earth adhering to their roots, to Mr. Delaunay's establishment where they are kept under sheds for from two to six months. It is during this interval that they are cut in measure as they are to be transplanted in the greenhouse. This business is delicate and requires great experience, since at this moment the buds are scarcely formed, and it is necessary moreover to keep only those that shall produce flowers. From one plant the gardener will cut but a few stems, and of another he will keep but a single branch of the entire shrub.

The principal greenhouse in which the lilacs are planted is about 160 feet in length, 23 in width, and 12 in height. The others, which are smaller, are excavated in the earth, and a semi-obscurity pervades all of them. The roof is composed of glazed sashes covered with a thick lattice work.

The soil is composed of ordinary earth without manure. All around the walls run pipes in which circulates hot water. There is at least a mile and a quarter of these pipes in all the hot houses combined.

The lilacs sprout at a mean temperature of from 30 to 35 C. During the day, when it is not freezing, the sashes are slightly raised in order to renew the air for a couple of hours.

The transplanting of the lilacs is done at intervals of two days, so as to have a continuous succession of flowers. The balls of earth adhering to the roots are scarcely buried in the soil, and the development of the plants is so rapid that bouquets may be cut from them within twenty days. The aspect of the greenhouse at this moment is charming. It is a perfumed forest of lilacs of dazzling whiteness, whose light and flaky bunches are a delight to one's eyes.

While the buds are forming there is one quite laborious operation that has to be performed, and that is the removal of all but the flower buds, so as to give the flowers themselves more vigor. In this heat of 35 C., the gardeners work in very light clothing.

The culture lasts ten months, from September to July. Mr. Delaunay sacrifices about two hundred thousand lilac plants in his establishment, for after this forcing they merely vegetate, then die.

For the culture of the snow ball the heat is the same, 30 to 35 C. The same care has to be taken as with the lilac, but the development of the flower is slower—it must remain in the greenhouse six weeks. As for rosebushes, two months of from 15 to 16 of heat are sufficient.

On New Year's day the consumption of bouquets of lilac is enormous, Parisian gardeners furnishing about 12,000 of them. They are also sent to England, Belgium, and Russia, to the amount of five hundred bunches per week.—*La Nature.*

FORCING HOUSE FOR LILACS.

[NATURE.]

THE SQUARE BAMBOO.

THE cylindrical form of the stems of grasses is so universal a feature in the family that the report of the existence in China and Japan of a bamboo with manifestly four-angled stems has generally been considered a myth, or, at any rate, as founded on some diseased or abnormal condition of a species having stems, when properly developed, circular in section.

Of the existence of such a bamboo there cannot, however, now be any kind of doubt. It is figured in a Japanese book, the "Sô moku kin yô siû" (Trees and shrubs with ornamental foliage), published at Kyoto in 1829, and the figure is reproduced by Count Castillon in the *Revue Horticole* (1876, p. 32).* It is further figured in a work for a copy of which we are indebted to my friend Prof. Kinch (formerly of Tokiyo), called the "Ju-moku Shiri-yaku," *i. e.*, a short description of trees (of Japan). Finally, in 1880, Messrs. Veitch presented to the Kew Museum fine specimens of the stem of the square bamboo, brought from Japan by their intelligent collector, Mr. C. Maries

M. Carriere states, in an editorial note to Count Castillon's article, that the plant had been introduced into France at that date, and was indeed actually on sale in the nurseries near Antibes.

Nothing, however, till quite recently, appears to have been known as to the existence of the square bamboo in China, from which country, however, it is extremely probable that the Japanese procured it. Thus, Mr. F. B. Forbes, whose personal knowledge of the Chinese flora is only second, perhaps, to that of Dr. Hance, informs me: "I have never seen the square bamboo growing, and I have always supposed that its 'squarity' was artificially produced."

The first authentic account of its occurrence in China is, as far as I know, due to Mr. Frederick S. A. Bourne, of H. B. M. Chinese Consular Service. Mr. Bourne wrote to us, October 15, 1882, that he had made a journey from Foochow to a distance of 300 miles to the western border of the Fokien province, reaching Wu-i-kung, the celebrated monastery in the Bohea hills—a place, Mr. Bourne states, "only visited by a European once before, I believe, *i. e.*, by Mr. Fortune, about the year 1845." In the gardens of this monastery he found several clumps of the square bamboo growing to the height of about eight feet

The *Tropical Agriculturist* (an astonishing repertory of everything relating to the economic botany of the East) contains in its issue for November, 1882 (p. 445), an article extracted from the *North China Herald*, also relating to the square bamboo, plants of which, destined for the park at San Francisco, had been obtained by

* The woodcut also appeared in the *Gardeners' Chronicle* for January 29, 1876, p. 147. I am indebted to the editor for its use on the present occasion.

Dr. Macgowan at Wenchow. I extract from this article the following particulars, which show the interest the Chinese themselves attach to the plant:

"Pre-eminence is assigned to the square variety of this most useful as well as ornamental plant, which has been a favorite in imperial gardens whenever its acclimation has been effected in the north. The Emperor Kao Tsu once inquired of his attendants, who were planting bamboos, concerning the various kinds. In reply he was informed concerning several remarkable species. Chekiang in particular furnished one that was an extraordinary curiosity, in that it was square, and for that quality and its perfect uprightness was much esteemed by officers and scholars. They also told him that it was used for many purposes of decoration and utility, including, among others, that of being made into ink-slabs. Subsequently specimens were obtained, polished, and sent to his majesty, who thereon signified his respect for the article by rubbing ink with his own hand on the inkstand, and inditing an essay on the curiosity. In 650 A.D. the reigning Emperor sent a eunuch to Chekiang to obtain specimens for the Imperial Park. Besides being furnished from scattered portions of this province, it is found in Honan, Szechuen, Yunnan and Hunan; in the latter province it appears to present its peculiar characteristic in a marked degree, being as square, with corners, and as well defined as if cut with a knife. The Chekiang varieties have slightly rounded corners, and moreover they are more slender, being used only as pipe-stems, whereas the western kind is large enough to serve as staves for the aged. In its early stage of growth the square bamboo is nearly round, assuming the anomalous figure it afterward presents as it advances toward maturity. Like several other kinds of bamboo it is thorny, abounding in small spines."

Dr. Macgowan being well known to botanists for his intelligent interest in all that relates to the vegetable productions of China, I ventured to write to him to ask

THE SQUARE BAMBOO.

his aid in procuring living specimens of this interesting plant for the Royal Gardens. Through his kindness and that of Mr. E. H. Parker, late acting consul at Wenchow, we were fortunate enough to receive a Wardian case filled with plants of the square bamboo, some of which at least appeared to be alive and likely to grow. Besides these, Dr. Macgowan sent us specimens of walking-sticks and pipe-stems made from it.

I quote the following passages from the very interesting communication with which Dr. Macgowan was also good enough to favor us:

"Its geographical range is from 25° to 30° N. latitude, littoral, and westward farther than I have been able to discover. Unlike other varieties of bamboo here, its shoots are developed in the autumn, not in the spring. It sprouts in September or October, and the stems grow until they are arrested by December cold, by which time they attain a height of from two to four or five feet. In the spring following, their growth recommences, when the grass attains its full height, ten to fourteen feet. The lower portion of the culms bristle with short spines; in the second or third year their squareness is far less striking than when matured by several years' growth; that quality is sometimes so marked that a native botanist describes them as appearing like rods pared by cutting instruments. I have seldom found the corners much more sharply defined than in the largest of the specimens herewith transmitted. It is cultivated chiefly for ornament in gardens, in temple courts, etc.; the larger stems (sometimes as much as an inch and a half through) are used for staves; the smaller and less squarish for stems of opium-pipes; and the smallest and less mature for tobacco-pipes."

He further adds: "Its anomalousness is attributed by the Chinese to supernatural powers—occult agencies varying with each district. The *Ningpo Gazetteer* tells how Ko Hung, the most famous of alchemists (fourth century A.D.), thrust his chopsticks (slender bamboo rods pared square) into the ground of the spiritual monastery near that city, which, by thaumaturgical art, he caused to take root and to appear as a new variety of bamboo—square."

As no flowering specimens of the square bamboo have reached the hands of botanists, its taxonomic position must at present be regarded as doubtful. Riviere ("Les Bambous," p. 315) refers to it as the *Bambou carre*, and Fenzi, quoting from Riviere (*Bull. Soc. Tosc. di Ort.*, 1880, p. 401) gives it the name *Bambusa quadrangularis*.

I can discover no reference to it in the late General Munro's classical monograph of the *Bambusaceæ* (*Trans. Lin. Soc.*, vol. xxvi.). Of the three groups into which he divides the genera, in only one, *Triglossæ*, is there any tendency to depart from the habit of the order in having anything but round stems; and this only occurs in the small genus *Phyllostachys*, in which they are somewhat laterally flattened. The stems of *Phyllostachys nigra* are often used in Europe for walking-sticks and light broom-handles.

But I do not think the square bamboo will turn out to be a *Phyllostachys*. Munro has a *Bambusa angulata* which is distinguished from all its allies by having the branches of the panicle angular. This is the only tendency to angularity of stem which I have discovered among the true *Bambuseæ*.

For the present, at any rate, the species must be known provisionally as *Bambusa quadrangularis*, Fenzi.

W. T. Thiselton Dyer.

RAILROAD CONSTRUCTION.

The following table shows the progress of railroad construction in the United States in detail from the year of its commencement in 1830:

Year.	Miles in Operation.	Annual Increase of Mileage.	Year.	Miles in Operation.	Annual Increase of Mileage.
1830	23	...	1858	26,968	2,465
1831	95	72	1859	28,789	1,821
1832	229	134	1860	30,635	1,846
1833	380	151	1861	31,286	651
1834	633	253	1862	32,120	834
1835	1,098	465	1863	33,170	1,050
1836	1,273	175	1864	33,908	738
1837	1,497	224	1865	35,085	1,777
1838	1,913	416	1866	36,801	1,716
1839	2,302	389	1867	39,250	2,449
1840	2,818	516	1868	42,229	2,979
1841	3,535	717	1869	46,844	4,615
1842	4,026	491	1870	52,914	6,070
1843	4,185	159	1871	60,293	7,379
1844	4,378	192	1872	66,171	5,878
1845	4,632	256	1873	70,268	4,097
1846	4,930	297	1874	72,385	2,117
1847	5,598	668	1875	74,096	1,711
1848	5,996	398	1876	76,808	2,712
1849	7,365	1,369	1877	79,988	2,280
1850	9,021	1,656	1878	81,717	2,629
1851	10,982	1,961	1879	85,463	4,746
1852	12,908	1,926	1880	93,349	6,875
1853	15,360	2,462	1881	103,145	9,796
1854	16,720	1,360	1882	113,713	11,568
1855	18,374	1,664	1883	121,454	6,748
1856	22,016	3,642	1884	125,379	3,825
1857	24,503	2,487			

MR. PETRIE ON THE GREAT PYRAMID.

Mr. Petrie is minute in his observations of the injury that the King's Chamber, the chamber containing the sarcophagus in the Great Pyramid, has sustained, apparently by an earthquake. The joints of the stones have been loosened on every side, and the great beams of the ceiling, weighing about fifty-four tons each, have been broken right through on the south side, and the chamber actually holds together only by the force of sticking and thrusting; its eventual downfall is, as Mr. Petrie says, "a mere question of time and earthquakes." As one of these cracks and many of the joints have been daubed up with mortar, it seems that the injury must have occurred before the pyramid was finished.

The sarcophagus, in which great interest was centered by Professor Piazzi Smyth's theory, as it was supposed to exhibit a standard for all the pyramid dimensions, is found by Mr. Petrie to be a rather careless piece of work. Marks of the saw which still remain show that the masons have more than once cut deeper than they intended, and have then tried to polish away their mistakes, but without wholly succeeding. The coffer was raised to see if there were any marks underneath it to indicate that it stood in its original place; but no such marks were found. Mr. Petrie gives some interesting details relative to the change that took place in the workmanship of the pyramid in the course of building. The site was leveled with great care, and the base laid out with wonderful exactitude. The basalt pavement on the east side of the pyramid and the limestone pavements on the other sides are splendid pieces of work, the blocks of basalt being all sawn and fitted together with the greatest accuracy.

The lower part of the casing, of which Mr. Petrie for the first time uncovered some blocks *in situ*, is exquisitely wrought, and so is the entrance passage; "the means employed for casting and cementing the blocks of soft limestone, weighing a dozen to twenty tons each, with such hair like joints, are almost inconceivable at present, and the accuracy of the leveling is marvelous." But the same excellence is not shown in the upper parts of the building; the upper part of the great gallery is much askew; in the ante-chamber, bad stone has been employed, and its defects rudely plastered over; and in the King's chamber, though it is composed entirely of magnificent granite blocks of admirable workmanship, there is an error in the leveling, causing a difference of two and a quarter inches between the courses on the northeast and southwest, an error which, if not due to natural causes, is surprising in such a piece of work as the Great Pyramid. In many places the stone has been left in the rough, to be dressed down when it was put into position, but which has been left undressed. Mr. Petrie suggests that the architect of the first period of the building died in the midst of his work, and was succeeded by one who exercised less careful supervision, and that thus the building was somewhat hastily finished. As the roofing beams for the king's chamber are all numbered, and marked for the north or south sides, Mr. Petrie thinks it probable that they were all hewn in the lifetime of the first architect, and fitted into position outside the pyramid, but were built into their place by the second and less careful architect.—*Chambers's Journal.*

OXYGEN IN METALS AND THEIR ALLOYS.

The author examines in what state does the oxygen penetrate into melted metals. In those— such as silver—where the affinity for oxygen is small, and where it diminishes as the temperature rises, so that the oxides of the metal are dissociated below the melting point, he considers that the oxygen is simply dissolved in the melted metal, and escapes when the metal begins to solidify. Hydrogen is occluded in the same manner by silver and iron, and sulphurous acid by copper. A simple solution of oxygen cannot thus be admitted in the case of metals whose oxides are not dissociated at high temperatures. In such cases we must admit that the oxygen is chemically combined with the metal, forming an oxide which dissolves in the excess of the metal.

It seems evident that the oxygen formed under such circumstances is the least oxidized compound which the metal is capable of forming. In case of copper this must be the cuprous oxide, and in case of iron and nickel the ferrous or respectively the nickelous oxide. Oxygen thus fixed in a metal profoundly modifies its properties. As the dissolved oxygen escapes at the moment of solidification, it is impossible, in consequence of the spitting, to obtain a dense, homogeneous metal free from air holes. The more rapid the escape of the oxygen the more marked are these effects. Hence the oxygen, dissolved in silver is more injurious than the hydrogen dissolved in cast iron, whence it escapes gradually. If we alloy with a metal which dissolves oxygen another metal which forms with this body a stable chemical compound, we may suppress, or at least diminish, the spitting.—*A. Ledebur.*

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